Editorials

Color in Hydraulic Tests

New advances in hydraulic engineering having the interest and service possessed by one shown in this issue are so infrequent that they compel unusual attention. The use of dissolved coloring matter in determining flow through long penstocks and hydraulic turbines is distinctly an addition to the methods previously available, though it is perhaps essentially a development of the old float scheme of gaging stream flow.

No little credit is due Mr. Johnson and his associates for developing this test into one of accuracy and simplicity. With this development disclosed so fully as in Mr. Taylor's article, little more than some accumulated experience is needed by any engineer who desires to use this novel plan.

The color test as so far worked out is of greatest application with fairly long pipe lines where any slight errors of introduction of and observation at exit are swallowed up by a long elapsed time of transit. Future use of the method will show how far Mr. Johnson's empirical rule holds for relation between initial, final and mean time of transit; then we may see if the true mean velocity is ever less than that observed in color runs—as might possibly be the case with a very large conduit of limited length and using a single midstream injection point. This test holds out interesting possibilities for determining flow in canals and possibly in some rivers, though a vast amount of development work is essential in securing proper injection of the color and in determining what constitutes the indication of mean velocity.

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Kicking Engineers Around in New York Departments

The huge sums of money that are being "saved" for New York City every day by proposed wholesale discharges of engineers in the city service and by the reductions of the salaries of such engineers as would be left is more creditable to the imagination than to the intelligence of the proponents. Here is an example—both of the "saving" and raving:

> New York City is being bankrupted by its engineers. It has just been brought out that the salaries of the engineers of the Public Service Commission amount to $2,300,000 annually. There are so many useless engineers on the payrolls in other departments that they are constantly devising means of spending the city's money in order to show some excuse for their jobs. The result is an unending series of sewer repairs, new sewers, changes of grades and widths of streets, new streets, and new improvements of all kinds. It is rumored that the engineers of the Water Board are now busy making surveys and borings for a $50,000,000 addition to the Catskill aqueduct. If two-thirds of the engineers on the payroll were discharged, the saving to the city and the taxpayers would immediately amount to millions of dollars.

Such talk almost answers itself. Some people, however, may not know that New York is building a vast rapid-transit subway system, the cost of which will run into the hundreds of millions, and those who do know it may not realize the number and complexity of the engineering problems that arise from such an immense task carried on in and beneath the streets of a great city. The subway, the new Catskill water-supply and many lesser works of large importance in the aggregate demand a good-sized army of competent engineers, many of whom must be paid large salaries.

If events prove that the present and earlier city administrations have entered upon more extensive public improvements than the taxpayers are willing to stand for, after real extravagance and waste have been cut down, then of course the engineers in the employ of New York City will stand up like men, as engineers always do, and take their fair share of the burden of readjustment. When it comes to being treated like old-time Harlem goats or "houn' dogs," that will be another matter, but until those in authority join in such irresponsible clamor as is now going on, the municipal engineers of New York will do best to continue to maintain a dignified silence.

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Contractors' Bids on Their Own Plans Declared Illegal

Asking contractors to furnish and bid on their plans is far too common. What appears to be a flagrant case of this kind has occurred at Seattle, Wash., but thanks to a clear-headed and courageous corporation counsel, a farcical proceeding that might have added difficulty to difficulty has probably been averted.

The Seattle incident is connected with proposed measures to stop leakage from the Cedar Lake reservoir. (See *Engineering News*, Jan. 21, 1915.) James E. Bradford, Corporation Counsel of Seattle, was asked to pass upon the legality of the following provisions from an invitation for bids:

> The method of treating the reservoir basin to reduce loss of water by percolation therefrom will not be specified by the City of Seattle. Contractors are invited to examine the site of the reservoir and submit their own proposals for reducing the loss of water.

Mr. Bradford first points out that the city charter (Art. VIII, Sec. 14) distinctly provides that all contracts for public improvements must be let "to the lowest bidder" after public advertisement for at least ten days, during which time "plans and specifications" for the proposed work must "be on file" and subject to inspection. This language, the corporation counsel rightly says, is so plain as not to be "even open to construction."

To remove any lingering doubts as to whether the charter provision is legally sound Mr. Bradford cites some telling sentences from Coshert vs. Seattle (57 Wash., p. 649-51), in which the court declared that this very provision of the Seattle charter was designed to prevent "favoritism, fraud and extravagance" by making "intelligent competition" possible and by affording a basis "for ascertaining who in fact was the lowest bidder." That the Washington court was not alone in this opin-

ion was shown by citing People vs. Commissioners of Buffalo County (4 Neb., 150), in which the court ruled that county commissioners could not contract for a bridge "when the only competitive bidding was upon plans furnished by the respective bidders." In line with both these decisions is Dillon's "Municipal Corporations" (Sec. 807).

The case against inviting contractors to bid on their own plan is made all the stronger at Seattle by the charter provision that the board of public works cannot pass upon who submits the *best* but only upon who submits the *lowest* bid. Where each contractor submits his own plan there might be as many plans as bids, no two upon the same basis, making it impossible to say which bid was the lowest.

To drive the argument home Mr. Bradford passes from charter provisions, court decisions and expert legal opinion to a common-sense statement of the case, the gist of which is that since sooner or later the city authorities must decide upon some plan for stopping the leaks they might as well do so at once, "without fear or favor."

As nearly as can be judged from across the continent, but in the light of evidence from other and apparently similar cases, the Seattle authorities sadly confused two things that should have been kept separate—the selection of a method of stopping the leaks and of a contractor to execute the plan selected.

If the authorities desired a competition on plans, why did they not confine their request for bids to plans alone? A plan selected, real competition could then be secured for its execution and all the bids would have been on a strictly competitive basis. But even this course would not warrant placing elsewhere than upon an engineer the main reliance for selecting a plan and awarding a contract for stopping the leaks from the reservoir. There are strong indications that Seattle and some other Pacific Coast cities have been governed too much of late by laymen who put a higher estimate on their own opinions in engineering matters than upon the judgment of engineers.

Leaves and Storm-Sewer Inlets

Unless storm-sewer inlets in tree-lined streets are properly designed, leaves may be thrown down by a heavy storm and the street drainage system go out of commission under the influence of a narcotic of leaves, sticks and mud. Just such a condition as this occurred during and just subsequent to a rain and hailstorm in Jackson, Mich., in August. This was the third storm of the sort to occur there this summer, and each time the same street was flooded by the stopping-up of sewer-inlet gratings. H. K. Higgins, of Jackson, Mich., writes as follows:

> These three storms show a marked phenomenon which the writer has frequently observed elsewhere—it is not the precipitation per se that causes flooding or measures its damage, but rather the uncleanliness of streets and water courses. In the third storm there was, nearly at the time of maximum precipitation (0.8 in. in 15 min.), a heavy hail with stones measuring 1½x1½x1 in. The hail cut the foliage from trees and the leaves clogged the catch-basin inlets, which have holes 2½ in. square and a slot about 21x4 in. (the Hall inlet). The water rose after the rain had practically ceased, flooding the street, which was being paved.

There are many designs of sewer-inlet protection. Which to choose depends upon a variety of local conditions, all of which should be given careful study. The Jackson incident shows what may happen with closely grated openings in tree-lined streets. But if the openings had not been closely grated it is conceivable that the sewers, at the time of this or a subsequent storm, would have been clogged by leaves and associated material and the streets flooded just as badly. It is the duty of the engineer to guard against either contingency as fully as is possible within the funds at his command. Beyond that, he must try to select the lesser of two evils.

Small Street Cars To Compete with Jitney Busses

The competition of the jitney bus continues to be the most actively discussed subject in street-railway circles from ocean to ocean. It may well be so, for the alarming decrease reported in the earnings of some roads means either a remedy or a receivership. In the last six months many investigations of the situation all over the country have been made and the results generally agree on three points: (1) The jitney movement has popular approval in most cases—in spite of broken-down and overcrowded vehicles—and severe restrictive ordinances do not have universal approval; (2) the business tends to limit itself through the narrow margin of profit secured even by free-lance owner-drivers who do their own repairing; (3) the impossibility of running nickel busses where licenses, liability bonds and police oversight are imposed to protect the public as fully as is done against the hazards of street-railway transportation.

The small net earnings won by jitney owners constantly eliminate many vehicles, but so far there has seemed to be a good supply of venturesome spirits each with his necessary one or two hundred dollars. Evidently the street railways cannot safely rely on the movement's dying by starvation. The popularity of the jitneys and frequent public disapproval of severe ordinance restrictions make the hope of legislating the movement out of existence a precarious one.

Naturally, then, the street railways are looking for ways of meeting their new competitor with more popular and cheaper service. The scheme most talked of now is that of replacing the very heavy cars which have come into vogue with very light and small one-man types. This would give the more frequent service, fewer stops and quicker runs which seem to keep the jitneys patronized; the railway would apparently gain through decreased motive-power, track-repair and platform-labor costs per passenger. In the course of time perhaps the unit overhead charges could be decreased through smaller investment in rolling stock and track construction, for the weight of cars and trackwork has gone up as the square of the capacity of the cars, or as some higher power.

Five years ago there was a strong reaction against the heavy street cars that were being run. Street-railway engineers were discussing the details that could be lightened without sacrificing carrying capacity and necessary strength. There was pressure from the administrative officials to cut down the maintenance and power costs, but the public had not shown its preference for a light fly-away service. Neither engineers nor administrators had the nerve to plunge into such a revolution of service as is now proposed, even if they realized the pe-

culiar relation between car capacity and total expenses. A few of the small one-man cars have been put into use, but it is too early to know how successful they really are. In crowded city streets two men have been found indispensable on a car, and where the new type has appeared an extra motorman has been put on to carry the car through the congested zone. Some need of educating the public and overcoming labor-union opposition seems to be called for, but there is a field for the service, at least in the smaller cities and on outlying lines, so that if this scheme is really the preventive of impending bankruptcy, as some think, such possible obstacles will be swept away.

Embedding Street Railway Rails in Concrete

Every engineer responsible for railway-track construction or maintenance will be interested in the new type of street-railway track which is to be laid in Charlotte, N. C., and is described elsewhere in this issue by E. R. Horton, the engineer who has worked out the details of the design.

In *Engineering News* of Aug. 6, 1908, was described the design for street-railway track developed for use in Charlotte by James N. Hazlehurst, then chief engineer. In that design wooden ties were used at the rail joints and at intervals of 12½ ft. between. The main supports of the rails, however, were the concrete longitudinals, to which the rails were held by U-shaped anchor stirrups.

The most noticeable feature of this track is the lack of ties. The rails are laid upon flat steel plates which are bedded on heavy concrete stringers. It is not such prominent features, however, which will be of the greatest interest to maintenance-of-way engineers, for superficially similar designs have been employed before—and without any phenomenal success. (A recent investigation of track construction in the larger cities of this country disclosed the existence of nearly 150 mi. of the tieless concrete type—about 2% of the total.)

What track engineers will look at will be the provisions for maintaining rigidity of the running rails, especially at the joints. Play would develop at the joints from the impact of car wheels and elsewhere along the track as the result of shrinkage of the concrete. Mr. Horton seems to have forestalled trouble at both points by ingenious and well-planned construction, particularly the use of wood inserts and spring washers at anchors.

No doubt the design will receive severe criticism from those who contend that a certain amount of elasticity is a necessary feature of railway track. The earliest track was laid with cast-iron rails on stone blocks, and it promptly proved a failure. Ever since, it has been argued that it is impossible to carry the rails on unyielding supports. On a cross-country stretch of railway track some elasticity is essential; a rigid roadbed all of whose parts possess equal resistance to compression, is a financial impossibility. Compression of the wooden ties and slight bending of the rails is necessary to take up the inevitable inequalities of the surface. But when rails are laid in paved streets, rigidity is essential to long life of the adjoining pavement and the expense of maintaining an embedded elastic track makes a rigid construction feasible.

The concrete stringers supporting the rails in Mr. Horton's design are made monolithic with the concrete street paving, which is carried to the top of the rail head. The rapidly increasing use of concrete for paving makes this design of special interest from this point of view also.

To Make the Home Safer

There is great promise in a piece of work recently started by the National Board of Fire Underwriters. Experts retained by the board are studying how the house—the ordinary separate "cottage" dwelling-house—can be made more safe against fire.

Many volumes have been written on fireproof construction, and inventors and manufacturers crowd the market with materials for building fireproof floors, walls and other parts in the cheapest and most effective style. There is also a fair amount of written knowledge on fire-retardant construction and on mill construction and the like. All this is for the office, the warehouse and the factory—but not for the home.

Dwelling-houses are not built fireproof (or if they are we call them mansions), nor are they built of mill-construction type. They are wooden structures, with the wood so subdivided as to present favorable conditions for rapid spread of fire. Their frames and walls form a multitude of interconnected cells, concealed hollow spaces communicating by way of cracks and by holes cut for plumbing and heating pipes and electric wires that are threaded through these spaces. Their construction does not meet the chief requirements of fire prevention. Baldly stated, a dwelling is a firetrap.

The insurance interests have for some years made a persistent campaign against the shingle roof; so persistent, in fact, that one might have thought all other elements of the dwelling-house to be acceptable. But the fact is that the fire dangers within the house are many and varied, and the roof danger singly may be by no means the most important point of improvement. Regardless of the relative magnitude of the interior and the roof hazards, however, the following is true: That if a campaign against interior fire dangers promises to yield large results and the campaign against shingles only a small result, it is high time to take up a study of the interior risks and get the campaign started.

Thousands of home builders throughout the country will be glad to have the results of this study. Today they lack instruction or advice on the subject. They know nothing of fire prevention in either the construction or the operation of the house, and as for fire-fighting provision they know even less. Perhaps it is advisable for every house to maintain an extinguisher on each floor. If so, let the underwriters determine this fact and publish it.

A 2% to 5% increase in the cost of a house can accomplish a surprising improvement from the fire-protection standpoint. There will be no great difficulty in inducing home builders to invest this additional amount, provided they are informed in detail how to reduce the fire risk. The underwriters have undertaken to show them how.

The underwriters might well go a step farther than merely preparing advice. They might adjust the rates accordingly. In business buildings the possibility of reduced insurance rates stimulates extra precautions. Should that be neglected among the householders?

Letters to the Editor

Improved Chuting of Concrete

Sir—The editorial note entitled "Concrete Chuting Predominant," in *Engineering News* of Aug. 12, was read with much interest. It appears, however, that *the one* very important factor that has silenced much of the objection to spouting concrete was omitted. The same is true of Mr. McCullough's letter in the issue of Sept. 2.

In the days when the gravity chute was more or less of an experiment many contractors saw therein a means of placing concrete very economically, and in order to make "records" with the rather crude apparatus then available (compared with the uptodate spouting plant), the concrete quite naturally was mixed very wet to insure its "flowing" in the chute. Then, also, there was a tendency to cut down the time of mixing, since no difficulty was experienced in getting the concrete away from the mixer, as had been the case with other methods. These two conditions naturally produced results which raised a storm of adverse criticism from engineers, for the great amount of laitance (decomposed cement formed in the presence of an excess of water) present did, without question, weaken the concrete. In one case with which I am acquainted a great number of laitance spots were found in a slab placed by chute. These never did harden and could be dug up easily with a knife to a depth of an inch or so. This without question was due to the excess of water used. The basis for the widespread criticism of gravity spouting of concrete was well-founded, and contractors and manufacturers were quick to realize that unless something were done to remedy the apparent faults, this type of apparatus would be barred by engineers and owners.

Accordingly, careful study was made of the proper angle of chutes and the consistency of concrete required to enable placing the concrete without the excessive use of water. It was soon found that, with a certain minimum angle of chutes, concrete mixed to the consistency of a thick gravy and having no excess of water would flow readily—such a mixture being surprisingly slippery and possessing a sort of oily smoothness. The addition of a small amount of hydrate of lime (up to 10% by volume of the cement) was also found to make the concrete flow more readily. To produce a mixture wherein the stone is held in suspension and the entire mass clings together requires more thorough mixing than is usually done, and herein lies the whole secret of chuting; excess water is not required.

With a little experience the man at the mixer can tell, by the following indications, whether the concrete is of the proper consistency to flow well in the chutes: If, when dumped into the skip or hoisting bucket, the concrete stands up in a pile, it is too dry and requires additional water and more mixing. If it levels off and shows a covering of water, it is too wet to hold the aggregate.

Not only must the mixture be right to insure successful operation, but the flow of concrete should be steady and continuous by proper regulation at the distributing hopper at the top of the tower. Increasing the time of mixing may make this last condition difficult of fulfillment, but this can be accomplished easily by having two mixers at each plant instead of the one usually seen.

Concrete chuting has come to stay because of the great economy of operation; it is the duty of the engineer to aid in obtaining the best results, rather than to forbid its use. Given a well-designed plant, all that the engineer needs to do, as his share, is to see that the concrete is properly mixed before being discharged into the chutes. This will remove the one great objection and actually result in stronger concrete than we now obtain with rapid mixing, even if there is no excess of water present. A paper read by H. H. Scofield before the Indiana Engineering Society gave the results of tests to ascertain the effect of mixing on the compressive strength of concrete. These tests showed that the strength was increased by from 27% to over 50% by lengthening the mixing periods from 10 to 18 min. over that of the usual ½ to 1 min. It would be impossible, of course, to increase the time of mixing quite so much, but with the aid of the mixer manufacturers, by building machines of higher speed, beneficial results can be secured.

Summing up the situation, the popularity of the gravity spouting system of concrete distribution can be increased still more by the use of high-speed mixers, a slightly increased time of mixing and careful supervision.

ALBERT M. WOLF,
Principal Assistant Engineer,
Condron Co., Structural Engineers.
Chicago, Ill., Sept. 8, 1915.

Lake Okeechobee Water Level

Sir—In the editorial columns of *Engineering News* of Sept. 2, 1915, under "Everglades Drainage Problems and Florida Rainfall," comment was made concerning the water level of Lake Okeechobee, the effect thereon of recent heavy rains and the condition of the surrounding territory. It was stated that last spring the lake was at its lowest stage and that as a result of recent heavy rains it was reported that the lake was at its highest stage.

It is clear that that part of the editorial relating to conditions on and about Lake Okeechobee was founded on incorrect information. The rainstorm of Aug. 1, 2 and 3, referred to in the editorial mentioned, extended in a more or less well-defined zone 40 to 50 mi. wide across the peninsular part of Florida, with St. Petersburg the center on the Gulf and Jupiter the center on the Atlantic side. During the three days, from 8 to 15 in. of rain fell, generally within the heavier storm area. The southern edge of the storm zone passed north of the middle of Lake Okeechobee.

The level of the lake as recorded for the week ending July 31 was 16.09 ft. above sea level; on Tuesday, Aug. 3, the level was 16.42 ft.; for the week ending Aug. 7, 16.63 ft.; for the week ending Aug. 14, 16.80 ft. The rise attributable to this storm was about 0.70 ft. The lowest level reached by the lake was 15.8 ft. during the autumn

of 1914. The lake overflows its banks on the south at El. 21.5 ft. The highest water ever recorded, not due to wind tide, is 21.8 ft. Okeechobee cannot rise above this level owing to the fact that at this elevation the lake spills over its entire southern rim for a distance of more than twenty miles, faster than there is any possibility of water being supplied to it.

The effect of the storm on Lake Okeechobee appears almost insignificant in consideration of the heavy rainfall. This is due chiefly to two causes—the storm was not sufficiently broad in extent to cause general extreme floods and followed a period of rain deficiency that had prepared the lakes and ponds in the Okeechobee drainage area and the ground itself for the reception of a large amount of water, without flooding. This flood cannot be used as a criterion by which to judge of what Lake Okeechobee can do when the opportunity is really offered.

At El. 16 ft. the navigability of the lake is but slightly impaired and this over shoals bordering the south and west shores. The lake is regularly navigated in and out of the canals on the south and east and Taylor's Creek by boats of 4-ft. draft, and there are more boats on Lake Okeechobee today than ever before. Three-fourths of the lake has a depth in excess of 8 ft. when the lake level is at 16 ft.

The remarks relative to the recommendations of engineers brought out in the editorial mentioned are concurred in by myself. The foregoing is offered, therefore, not in regard to the comment on the recommendations, but in correction of the erroneous information that must have been supplied you relative to Lake Okeechobee.

Work on the canals and regulating works for controlling Lake Okeechobee is progressing.

F. C. Elliot,
Chief Drainage Engineer,
Everglades Drainage District.

Tallahassee, Fla., Sept. 8, 1915.

Does Good Iron Preserve Paint?

Sir—"Good Bridge Paint" in your issue of Sept. 9 refers to endurance of paint on a wrought-iron highway bridge for 37 years. You point out that "here is a remarkable record of paint endurance." I believe that your emphasis should be placed on the good quality of the iron rather than that of the paint. This wrought iron it would seem to me was of such purity that paint in the first case lasted 17 years and in the second case at least 20 years. With inferior quality of iron or steel, how long would either coat of paint have lasted?

I have been told that wrought-iron links which were underground at the well-known Chain Bridge at Newburyport, Mass., were intact and free of rust after 100 years of service. From personal observation I can say that the iron of this bridge was remarkably free of rust 75 years after it was built, and I attribute this endurance to the quality of the wrought-iron rather than to a protective coating.

From experiments that I have been making toward rustproofing of steel and iron I have concluded that paint or other protective coating depends for its endurance upon one important factor that must be emphasized; namely, the quality of the underlying surface of iron or steel. If the surface is rusty, scaly, granular, wet or greasy, trouble is very apt to occur; and if the surface is smoothed off, even by sandblasting, impurities in the metal itself reacting with the paint or other coating will often start disintegration. But with pure wrought iron "such as they used to have," rust does not readily occur and paint easily endures.

The subjects of rust, bridge paints, and protective coatings that will withstand atmospheric and gaseous conditions without costing too much are worthy of more discussion by engineers. It should be practicable to obtain better results than we are getting.

F. B. Sanborn,
Consulting Engineer.

Tufts College, Mass., Sept. 12, 1915.

Earnings of Graduate and Nongraduate Engineers

Sir—Referring to my letter under the above title published in *Engineering News* of Aug. 12, p. 325, and your editorial comment thereon, I have gone to the pains of making a tabular comparison on the basis which you suggest, that is counting the experience in engineering to begin when a student enters college and not when he graduates. On this basis the comparison is as follows:

Years' Experience	Monthly Salary College Men	Monthly Salary Non-College Men
1	$00	$67
2	00	78
3	00	95
4	00	105
5	67	107
6	85	115
7	110	120
8	122	130
9	133	137
10	145	145
11	160	150
12	175	160
13	190	170
14	200	180
15	210	190
16	225	200
17	240	210
18	250	220
19	275	225
20	275	225
21	285	225
22	285	225
23	290	225
24	300	225

Assume that the college course lasts four years and costs $1000 a year. That is $4000 invested, noncompound interest on which at 5% for the first five years after graduation (when the graduate's earnings become equal to the nongraduate) is $1000; and during the same time the shortage in his pay compared to the other man's amounts to $1104. At the end of six years, then, he is $6104 behind. The interest on this during the next nine years is $2745, and his extra earnings amount to $2640, about balancing that. Then his extra pay begins to wipe out the principal and in six years extinguishes it. It is now 21 years since graduation, and from this time on the graduate gets $900 a year more than the nongraduate. But by this time half of the graduates have dropped out. So that the conclusion is that in, say, 20 years the college education will pay for itself, and as only half stay the 20 years out we may say that for half of those who graduate college pays.

The figures used above are supported by data at the beginning and end of the term; intermediate ones are interpolated. The figures for the end of the term are taken from the diagram in your issue of Jan. 7, 1915, the line for graduates being shifted four years to the right so as to make their experience date from college entrance.

Civil Engineer.

Nashville, Tenn., Aug. 17, 1915.

Automatic Cab-Signal and Train-Stop System

SYNOPSIS—This railway signaling system gives both visible and audible signals in the engine cab, and supplements these by a service application of the train-brakes if a "stop" signal is disregarded. A special feature is that the connection between the track and engine equipment is by magnetic influence only, so that no contact is required.

An interesting example of the development of cab signals and automatic train stops is found in a system placed, on Sept. 22, in service on the main line of the Western Pacific Ry. This installation comprises five miles of track at the district terminal at Oroville, Calif., and 20 locomotives used at this terminal are equipped with the necessary apparatus. The distance is divided into four block sections. There are 9 fixed-signal locations, at which 20 track devices are arranged for giving 15 cab-signal indications and 7 automatic-stop operations. The system has proved satisfactory under unfavorable conditions caused by snow and bad weather.

Both visible and audible signals are given in the engine cab for three indications—"proceed," "proceed under control" and "stop." Electric lights (green, yellow and red) form the visible signals. The others are whistles of three distinct tones, which continue to operate until the connections are restored to normal position by the engineman. If signals are not obeyed, the automatic train stop gives a service application of the brakes. This cannot be released until the train has been stopped, but it does not prevent the further application of the brakes by the engineman. Provision can be made for rendering the train-stop device inoperative when the speed is below a given rate.

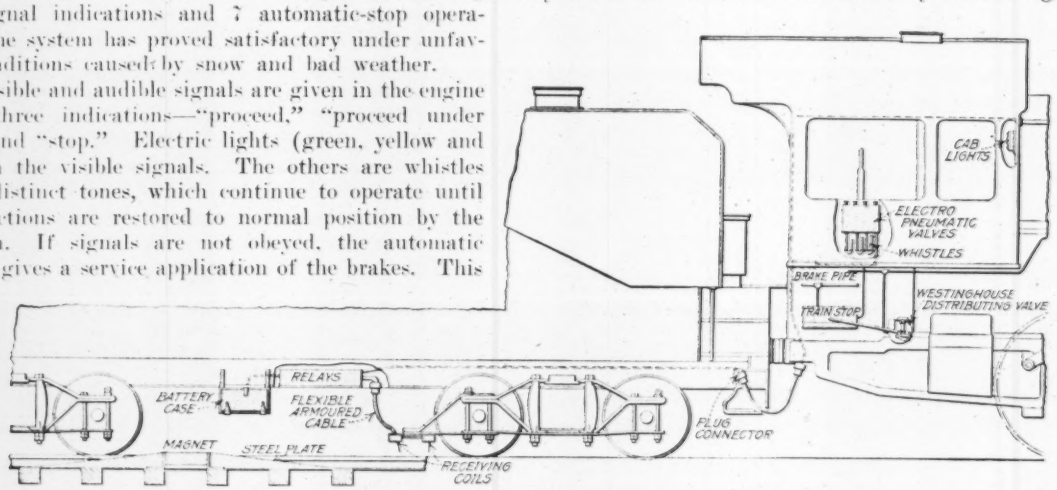

FIG. 1. TRACK AND ENGINE EQUIPMENT, BOSTWICK CAB-SIGNAL AND TRAIN-STOP SYSTEM

The transmission of signals from the track to the engine is effected by magnetic impulse only, and there is no electrical or mechanical contact between the parts on the track and those on the engine. The general arrangement is shown in Fig. 1. The track magnets are located between the rails, there being one for each of the three signal indications and a fourth for the train stop. Each track magnet, when energized, transmits signals for traffic in either direction.

The magnet is inclosed in a waterproof case 15⅞ in. long, resting on the ties and having its upper surface 1¾ in. above the rails. It requires an energizing circuit of 5 amp. at 10 volts, and normal operation takes current for 15 sec. only. The magnets are protected from hanging brake rods, etc., by 48-in. ramps or inclined blocks faced with steel plate.

Beneath the tender is a cross bar carrying the receiving coils, one for each signal and a fourth for the train stop. Each coil receives and transmits magnetic-impulse signals for traffic in either direction. This is shown in Fig. 2.

Each track magnet is so located that the corresponding receiving coil on the tender will pass directly over it. The cross bar carrying the coils is so placed as to provide a clearance of 3 in. between the magnets and coils. The extreme lateral or vertical movements of the engine cannot carry the receiving coils out of the magnetic fields of their respective track magnets or cause wrong signals to be given. Each magnet is entirely inclosed by a substantial, water-tight metal box, amply protected from injury. There are no moving parts in or about either the track magnets or the receiving coils.

Each fixed signal location has a standard railway battery set of 10 volts, with the necessary controlling and protective relays, wiring and trunking, and one or more track magnet boxes, according to signal needs. By means of a local track circuit, the track magnets are energized when an engine is 66 ft. distant and remain energized until after the tender has passed over the track magnet boxes at that location.

The apparatus on the engine consists of 4 receiving coils, 4 relays, a storage battery of 2.5 volts, 4 electro-magnetic-control air valves, 3 electric lights, 4 whistles and the train-stop appliance. A receiving coil, actuated by its energized track magnet, transmits the signal impulse through its relay, electric connections and air valve to its cab light and whistle. The train-stop apparatus is similarly controlled and actuated, except that its valve is vented. Each operation of the train stop is automatically registered and the engineman held accountable therefor.

A visual signal at each train-stop location is the only roadside signal used. This consists of a simple, hooded, two-light marker for proceed indications, operated from the battery at that location. Closed circuits are used

with electric control. Wherever air control is used, any leak or break will cause warning signals to be set against approaching trains. Fig. 3 shows one of the fixed-signal installations at the end of a block, with the relay cabinet and the track magnets.

The receiving and relay coils are of relatively high resistance. The relay magnets are powerful enough to

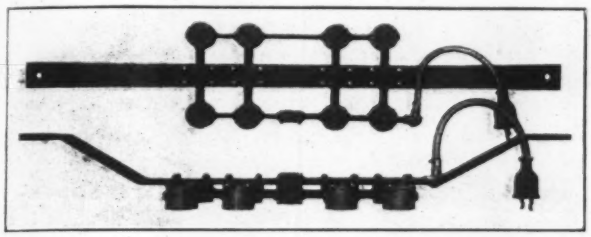

FIG. 2. GROUP OF RECEIVING COILS ON LOCOMOTIVE TENDER TRUCK FRAME

prevent contact from being opened through any engine vibration or shock, and the battery current is not essential to perfect relay operation, but is used to give protection against the breaking or loosening of any wire or connection.

The operation of the signal device is shown in Fig. 4. As the receiving coil passes through the field of the energized track magnet, a current is generated in it which is more powerful than, and flows in the direction opposite to, the battery current normally circulating in the receiving coil and relay. The action of this induced current momentarily reverses the magnetism of the relay, permitting its armature to drop and open the circuit to the cab apparatus. The armature is immediately reattracted to normal position. This interruption of the circuit deënergizes momentarily the iron-clad magnet *A*, causing the release of its armature *B*, which normally is tightly held to the poles of the magnet.

The lever *C* rises with the armature, and the air in the air supply pipe (connected with the engine main air reservoir) is thus permitted to unseat the valve and flow to the whistle. At the same time, the disk *D*, rising with the armature stem, closes the contact springs *E* and lights the lamp. The armature is restored to normal position only when the knob *F* is depressed, which opens the contact springs, thus cutting out the signal light and closing the air valve. Fig. 5 shows the whistles and their control valves.

The foregoing description applies to each of the three sets of apparatus for signal indications. A fourth set of the same apparatus, omitting the lamp, is provided for the operation of the automatic stop. This is operated in the same manner as described except that the valve connecting with the automatic stop (outside and below the cab) is a vent instead of a supply valve. The alarm whistle of the automatic stop is located in the base of the automatic-stop valve apparatus. When the automatic stop has been operated, pressure on the knob *F* restores the vent valve to normal position, but the service application of the brakes given cannot be released until the train is stopped, when the engineman must restore it from the ground. The necessary reversal of the operation of the receiving coils when an engine has been turned is provided for by a reversing switch.

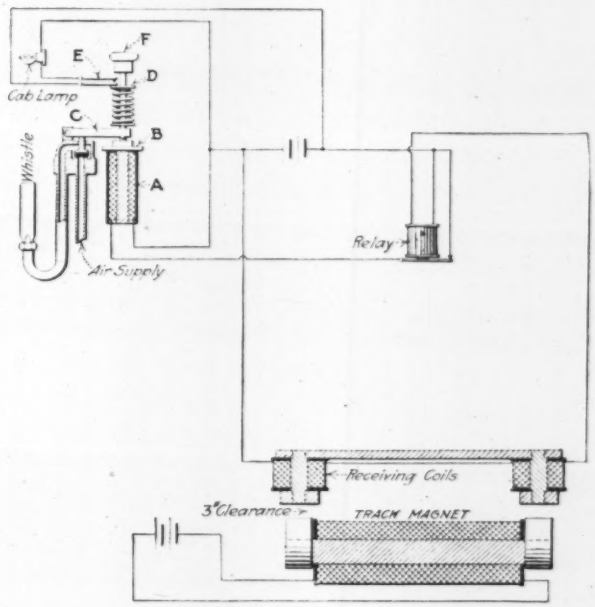

FIG. 4. DIAGRAM OF TRACK AND ENGINE EQUIPMENT

The train-stop device (Fig. 5), is connected to the brake pipe, and is pneumatically operated and electrically controlled. When it has applied the brakes they cannot be released until the device is restored to its normal position (although an emergency application can be made). This requires first pushing the knob of the electric vent valve in the cab, and then pushing the release button of the tandem valve, which can be reached only from the ground. When this is done, the engineman can release the brakes and proceed, subject to the indication of the roadside signal or marker. When two locomotives are attached to a train, the automatic stop is operative only on the head engine.

The circuits are shown in Fig. 6, but only as controlling the train stop. The block sections are insulated in the usual manner, and failure of any part of the appar-

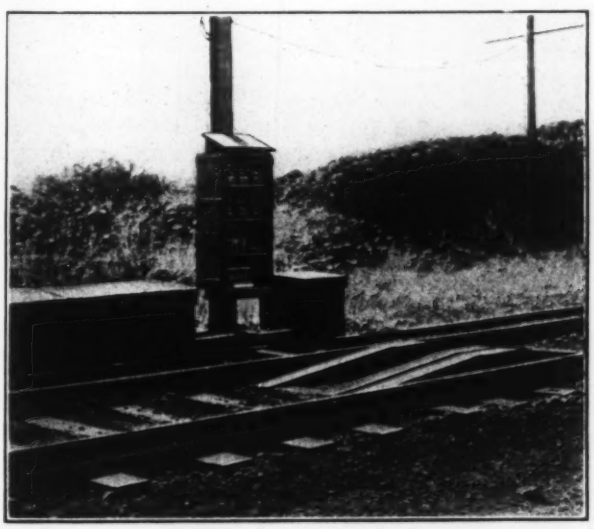

FIG. 3. FIXED SIGNAL INSTALLATION AND TRACK MAGNETS AT A BLOCK SECTION

atus will cause the signals to be displayed in the same way as if the block were occupied by a train.

Block No. 1 is supplied with current at *A* by the track battery *B*, the current being carried by the rails to *C* and thence to the relay *D*. In normal position, with no trains in the block, this relay attracts its armature

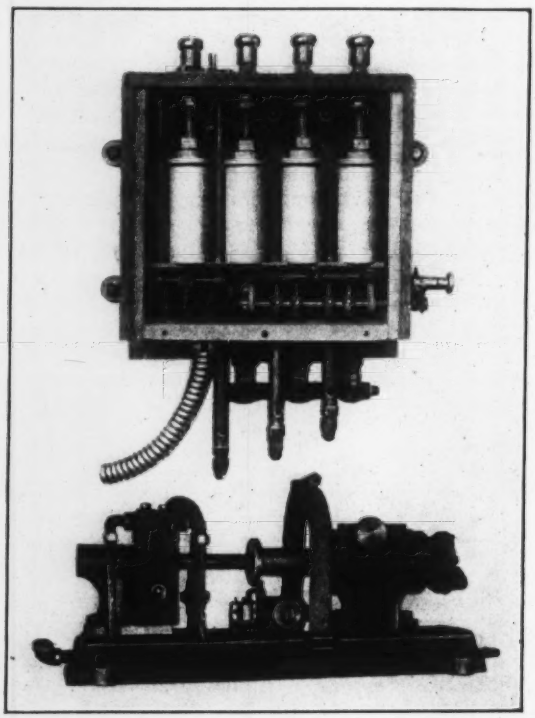

FIG. 5. AUDIBLE SIGNALS AND TRAIN-STOP

The upper view shows the signal whistles, with their electro-magnetically controlled air valves. The lower view shows the train-stop device in its open position

and connects battery *E* with the line relay at the far end of block No. 2. This latter block is supplied with current in the same way (at its far end), and the relay *F* connects its battery *G* with the line relay *H* of block No. 1.

Should opposing trains enter the two blocks simultaneously, the current supplying relays *D* and *F* would be cut off. These relays and the line relays would then drop their armatures, thus giving the signal indications in the engine cabs. The spacing of the signals is sufficient to enable the engineman to stop the train before coming to a "stop" signal, but the train-stop connection is set far enough in advance to bring a train to a stop before it can enter the danger zone.

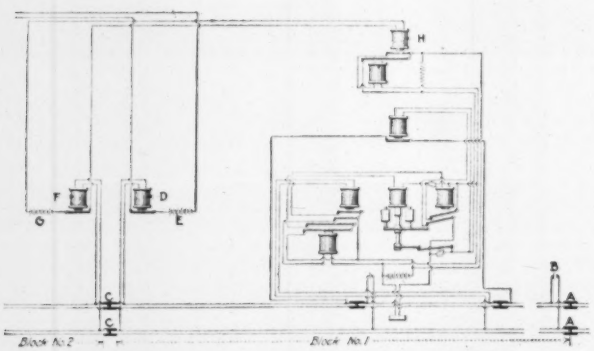

FIG. 6. DIAGRAM OF SIGNAL CIRCUITS

The automatic cab-signal and train-stop system here described is the invention of F. F. Bostwick, who is President of the National Safety Appliance Co., Mechanics Institute Building, San Francisco, Calif. The equipment described has been developed by W. S. Levin, chief engineer of the company, who has been in sole charge of design and construction, and to whose practical inventive ability is credited the successful completion of the system. It is applicable to single and double track, and for steam and electric traction. It may be used with or without the train stop. It can be applied also in connection with existing signaling and interlocking plants.

New Process Recovers Potash

New schemes for winning potash from American sources of supply continue to show the ingenuity of engineering chemists. The latest announced process was described by Edward Hart, of Lafayette College, Easton, Penn., in the August issue of the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society. A plant has been erected by the Clinchfield Products Co., at Erwin, Tenn., in close proximity to supplies of cheap coal and barytes, both of which are needed. The potash to be recovered is contained in large quantities of refuse from feldspar mines, running as high as 9% in potash and 15% alumina.

Briefly, the process consists in heating a mixture of feldspar refuse and barytes in proper proportion in a reducing atmosphere where a barium-aluminum-potassium silicate results containing about 36% silica. This is run into water while molten, and the granulated material is ground and floated. The settled material is then treated as a paste with the proper quantity of sulphuric acid, which decomposes it perfectly, giving a solution of alum and aluminum sulphate and a solid residue consisting of nearly equal parts of very finely divided barium sulphate and silica.

It might be supposed that the silica would be so gelatinous as to be unwashable, but this has not been found true. On the contrary, where properly manipulated, the precipitate is somewhat granular, but entirely free from grit, and forms an excellent material, after ignition, for use as a pigment in printing ink, rubber incorporation and as a coating for paper.

The solution, when evaporated, yields the potash as potash alum, and if the little iron present be kept in the ferrous condition, this alum, after washing with a little water and whizzing, is entirely free from iron and well suited for the preparation of pure potassium sulphate and iron-free alumina or aluminum sulphate, as desired. It is intended to sell the alum as such so far as the market will take it and to decompose only so much of it as may be necessary. This process may therefore furnish no potash at all. But inasmuch as potash for alum production now comes from overseas, this method is an indirect contribution to the supply.

The solution never contains enough potash to precipitate all the aluminum as alum. An excess of aluminum sulphate remains in the mother liquor together with the sodium and a little iron. This is allowed to cool and is broken up, furnishing a material equal in value to that now made from bauxite.

Color Used in Hydraulic Tests of Power Plants

By Roy Taylor*

SYNOPSIS—The injection of coloring matter has been employed in the roughest class of hydraulic-flow measurements, but very little has been reported of the possibilities of this test for accurate determinations. Details are presented of the method and apparatus developed by R. D. Johnson and associates for color tests at the Niagara Falls and Salmon River plants of the Ontario Power Co. Use of potassium permanganate and aniline dyes.

The use of coloring matter in water for rough measurements of sewer velocities, river currents and to detect leakage through dams is not unknown; but engineers in general fail to realize the practicability of this scheme in the measurement of water consumption at hydro-electric works and similar hydraulic developments where there are long pipe lines. This is no doubt because of the slight information of a practical nature published on the more refined color tests. The writer contributes these notes on two specific cases in the hope of helping to fill the gap.

It is hardly necessary to discuss the fundamental idea of the color tests beyond stating that the coloring matter is injected into the pipe system at a known point and at an observed time, the interval being recorded before it appears at the outlet of the pipe line or power plant. The computation of quantity of water flowing is extremely simple; it merely requires dividing the total volume of the system, between points of introduction and observation, by the time. The actual practice required for accurate color tests is not so simple as the preceding statement, as will be evident from the descriptions of trials at the Niagara Falls and Salmon River plants.

Color Tests Made at Niagara Falls

Several years ago color was used in a series of tests conducted at the plant of the Ontario Power Co., Niagara Falls, to determine the relation between quantity flowing and loss of head in its two 18-ft. conduits. These are each about 6,300 ft. in length, one round in section and built of steel, the other slightly oblate in section and constructed of reinforced concrete. These first tests were not extensive, but served to bring out the possibilities of the use of coloring matter in the measurement of water, so that during the summers of 1913 and 1914 a complete calibration of the plant was made and valuable information as to head losses, water consumption, velocities and efficiency of each of the 14 units was obtained.

It was decided to use color for these tests for several reasons: It had proved satisfactory in the first instance; to construct any form of weir in the tailrace was almost impossible, and, finally, as it was dangerous to approach and work near the tailrace, it was impracticable to use any method involving the percentage of solution and requiring constant taking of samples. The color method was therefore adopted for all measurements of water. When a few difficulties had been surmounted and the methods of running the tests had been systematized, results were obtained which are believed to be as accurate, if not more so, than could have been obtained by the use of any other method, not excluding that of weir measurement in this case.

Prior to testing the efficiency of each separate unit, a series of color runs was made on the two conduits to obtain an accurate relation between the flow in the pipe and the corresponding quiescent gradient level existing in the spillway on conduit No. 1 and in the surge tank in the case of conduit No. 2. These water levels were very sensitive to changes in conduit velocity, so that once the relation was established it became an easy matter to compute the flow in the conduit at any time by referring to the water-level chart of a recording graphic meter.

Introduction of Potassium Permanganate

The Niagara water is always comparatively clear, and the color runs in general occupied less than 12 min., so that potassium permanganate proved to be the most satisfactory, and at the same time the most inexpensive, substance with which to color the water. It is a very powerful stain turning the water a dark purple color, and the commercial product is easily obtainable at a price of less than 20c. lb. (with an ordinary market). It comes in the form of small crystals and can be introduced into the water without further preparation as it dissolves very quickly.

In the present instance, to introduce the color properly at the forebay entrance to the pipe lines presented a considerable problem, as the center of the pipe was 15 ft. or so below the floor and the velocity was over 18 ft. per sec. After failures with several rigs a device made up of iron pipe was constructed (see Fig. 1) which proved definite in action and simple in operation. The rod running through the handle was first drawn up and fastened with a pin so that the cover or piston on the end of the rod acted as a cork in the 4-in. cylinder; then the dry crystals were poured into the cylinder through a hole in the side, having a removable plug. The pipe was lowered into the water and at a definite time the pin removed and the handle rammed down, the end piston uncorking the cylinder and the upper piston ejecting the entire contents into the current almost instantaneously, at a point very close to the center of the pipe.

An observer stationed on the power-house roof noted the time to the nearest second, when the first trace of color appeared, the time of maximum color density and the time of the last trace. The mean time between the first and last trace, which usually corresponded to the time of maximum density, was used in computing the total elapsed time. (The reason for this will be discussed later.) Watches held by the man introducing the color and by the distant color observer were carefully checked by telephone after each run. The amount of color injected for one shot depended somewhat upon the conduit velocity

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and the load conditions existing at the time, but it never exceeded one cupful of crystals. The amount was constantly varied, the aim being to use sufficient to make the color clearly and sharply visible to the observer and yet not enough to drag out the persistence of color unnecessarily and make the readings indefinite. An observer at first will experience some difficulty in catching the time of maximum density, but with a little practice it becomes comparatively simple.

Over 60 runs were made by this method on the two Niagara conduits, embracing flows as low as 2,000 cu.ft. per sec., or a conduit velocity of 8 ft. per sec., and a maximum flow in the concrete conduit of about 6,600 cu.ft. per sec., corresponding to a conduit velocity of 26 ft. per sec.

Testing Power Units by Color Runs

To test each unit separately the color had to be forced into the penstock, at a convenient point near its upper end, with compressed air in order to overcome the pressure head of 50 ft. existing at that point. The apparatus shown in Fig. 2 was devised to accomplish this and could be easily attached to any penstock and connected up to

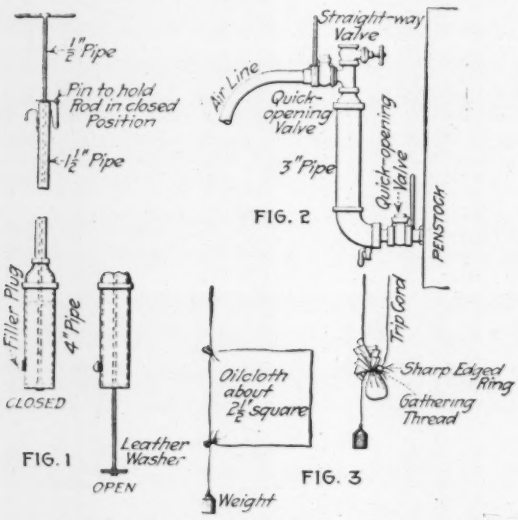


FIG. 1 FIG. 2 FIG. 3

COLOR INJECTORS FOR HYDRAULIC TESTS

Fig. 1—Dry potassium permanganate injector. Fig. 2—Compressed-air permanganate-solution injector. Fig. 3—Dye bag and release

an air line near-by. The permanganate crystals were dissolved in water (saturated solution) and about a pint of this liquid was sufficient to give a good color. A charge of this size could be poured into the cylinder and by means of the compressed air could almost instantaneously be injected into the penstock with a force sufficient to carry it well into the stream. In filling, the quick-opening valves were closed and the cylinder drained through the pet cock; then the straight-way valve was opened and the stain poured in. In discharging, the filling valve was closed and the air-line connection opened. At a definite time the valve at the penstock was opened and a bell signal given the discharge observer. In refilling, the penstock valve was shut and air pressure cut off; then the air pressure was released and the cylinder drained through the pet cock.

The schedule adopted was to hold the machine under test at a certain constant gate opening and, when all disturbances of the water had quieted down, to introduce six injections of color at about 1½-min. intervals. The observer was stationed on the power-house roof with a stop-watch and an electric buzzer beside him. The latter was connected to a push-button in the valve chamber where the color was put in. Two rings were given the observer as a warning 10 sec. before the introduction of color, followed by a signal-ring simultaneous with the opening of the valve and injecting the color. At the signal bell, the observer started his stop watch and later recorded the color appearance (to ¼ sec.), as previously described, in this way eliminating all errors due to watch corrections by having all times recorded to a single watch. The elapsed time before the color passed completely through to the tailrace on full-load runs was only about 31 sec., so that accuracy in time recording was of great importance. In computing the results, to eliminate small discrepancies, the six runs were averaged and considered as one point on the efficiency curve. The gate opening on the machine was then changed and another set of runs taken.

Slight errors in time resulted from the various lengths of paths followed by the particles of water in getting through the turbine casings. On conduit runs any error thus caused was so small a part of the total elapsed time as to be inappreciable; but in the runs on separate units where the total elapsed time was in some cases as low as 31 sec. it affected the results to the extent of from 1 to 2 per cent. As this error was practically the same on all machines, it could be corrected in the final results by arbitrarily revising the computed drafts of each turbine proportionately, until their total checked with the accurate measurement of flow in the conduit as determined from the gradient level in the tank and spillway. By this process the true efficiencies of the different wheels at all gates were obtained.

Tests at Salmon River Plant

The results of these Niagara tests were so uniformly satisfactory that upon the completion of the Salmon River Power Co.'s plant at Altmar, N. Y., it was decided to conduct similar tests to determine the best ways and best gates at which to operate the four 7,500-kw. units, their efficiencies, the frictional losses in the pipe line, and to calibrate the tailrace weir so that the records from it could later be used to keep track of water consumption. This work was carried out during October and November, 1914, under the direction of R. D. Johnson, who had previously supervised the tests made at Niagara. The color method was adopted in this instance because sufficiently accurate and at the same time less expensive to carry out than any other.

As this Salmon River plant is typical of a large majority of long-pipe-line hydro-electric developments, the methods used and the results obtained will be discussed in some detail.

The general features of this plant are as follows: The water is carried from a large reservoir by means of 600 ft. of rock tunnel, 7,800 ft. of 12-ft. wood-stave pipe and 1,200 ft. of 11.5-ft. steel pipe, making in all nearly 10,000 ft. of conduit. This leads to the top of a high bank just above the power house. From here it is dropped down the hill in four 8-ft. steel penstocks each connecting with a 7,500-kw. unit in the power house. On leaving the draft tubes the water flows out under a curtain wall at the end of the power house, through a rock cut to a

concrete weir wall several hundred feet downstream, thence through a rough artificial channel into the river some distance below.

Use of Aniline Dye

The same substance that had been so successfully used in the clear waters of Niagara River proved to be absolutely invisible in the dark brown waters of this river, even when introduced in large quantities. The reservoir had been filled but shortly before, leaving a large quantity of vegetable matter in the water. Upon this the strong oxidizing properties of the permanganate acted and during the 2-mi. journey, changed from its natural deep purple color to a muddy brown very similar in shade to the vegetable-stained river water.

It therefore became necessary to procure a brilliant red aniline dye which would be unaffected by the character of the water. Before diluting this dye in water it is a bright red, but when a small amount of it is put into a considerable quantity of water it gives the solution a light green opaque color (by transmitted light). To the observer this color is very clearly distinguishable against the dark brown of the water. Observations of the color were taken at the point where the tail water emerged from the power house and noted the usual three times. On some of the long runs, occupying over an hour, the presence of the color could first be detected by the flecks of foam taking on a pink shade (from reflected light), and in all cases this coloring of the foam seemed to be a very sensitive indication of the first trace of color reaching the tailrace. It is a good idea to purchase the dye in what is called a paste, but which really is a semi-liquid, for the powdered form cakes when put in water and has to be thoroughly dissolved in hot water before it is fit to use.

Importance of Quick Injection

Too much emphasis cannot be placed upon the importance of introducing the coloring matter in the proper way. Any failure of the injecting apparatus to work, premature dumping of the color, leakage, or fouling of the operating apparatus causing the color to dribble out slowly—all are invisible to the man operating it, so that under any of these conditions the time of introduction is at best very vague, if not altogether unknown, producing results of no value. Any apparatus that is uncertain of operation cannot fail to cause a lack of confidence in all results obtained. The color should always be injected suddenly; it should be in a form which will quickly dissolve or dilute and it should also be released where it will be sure to be caught by the current and whirled immediately into the main flow.

The case in question presented particular difficulties, as the only place where the color could be introduced was through an opening in the gate-house floor just behind the screens. The water surface stood 30 ft. below this floor and the pipe entrance 15 ft. below that. Fig. 3 shows a form of device that proved to be very definite of action and satisfactory in every way. A pint or more of the color could be held in the bag formed from the square piece of oilcloth. The bag was closed by gathering at the top and bound around with a thread. On the trip cord was fastened a sharp jagged wire ring through which this gathering thread passed, so that when the color had been lowered to the desired point, the trip cord could be jerked at a definite time, cutting the thread and releasing the color in one compact dose with no chance of its being strung out.

The time taken by the color to make its way down the pipe through the penstocks and units, into the tail race varied from 12 min. with all four machines running at full gate, to 1 hr. 23 min. with only one wheel running at 0.4 gate.

During all the tests the electrical load carried by the plant was tied in with that of the Ontario Power Co. at Niagara Falls so that any fluctuations of commercial load were carried by that plant and it was possible to put the Salmon River units under hand control during the entire runs thereby holding the gate openings constant.

Checks on Color Tests

Weir readings in the tailrace were taken every ½ min., and the quantity figured from a discharge curve previously made up. This was used as a check on the color runs. Two other rough checks were possible by figuring the quantity from the turbine gate openings considered as submerged orifices, and from the electric load and estimated efficiency characteristics. Readings of the water level in the surge tank at the top of the penstock and pressure gage readings at the bottom of the penstock were taken so that pipe-line losses, penstock losses and net operating head could be determined. The surge tank level, especially for large flows, became very sensitive, and when a loss curve was established this level became an accurate way of checking the results of any single color run.

The total volume was carefully figured and as the different units were taken up small corrections were made for the different tailrace lengths and short sections of pipe line between penstock entrances.

When two or more wheels are tested together the gate openings should be kept about equal, especially in the case of long penstocks, as otherwise the color will be strung out, moving faster through one penstock and wheel—that is, the larger gate opening—than through the other. In figuring the volume all penstocks, wheel casings and draft-tubes must be included. Errors are easy to make and should be guarded against wherever a division in the channel, pipe, or water course takes place.

Eliminating Discrepancies in Results

With all these various factors dependent upon one another it is apparent that any error resulting from incorrect readings, poor observations, wrong times, or freaks of eddy currents and waterwheel runners, invariably can be picked up and investigated. Unavoidable discrepancies, by weighing the causes of error, can be smoothed out and adjusted until the final results have a higher degree of accuracy than it is possible to attain from any one system of measurements. Provided no freak is found, the friction-loss curve, the weir-discharge curve, the curve between gate openings and quantity and the wheel efficiency curves, should all be relatively smooth and the results of any one run should fall on them all or be investigated.

As an example of the value of this checking one case may be cited. The tests on one unit disclosed the fact that the relation between gate opening and draft was not like that on the other units, and that the efficiency had fallen off. The wheel was shut down and upon

examination several large blocks of wood were discovered jammed between the runner vanes.

About 40 color runs in all were made in the tests at Salmon River, and two facts of special interest were brought out—the time between the first and last trace was invariably equal to about one-tenth the total elapsed time, and the maximum density of color occurred at about the mean time between the first and last trace.

Injected Color Strings Out

The first phenomenon is interesting since according to the supposed theory of flow in pipes a great deal more stringing out of the color should have occurred, owing to the difference in velocity at the center and along the surface of the pipe. This may be accounted for by the fact that the separate particles do not flow along in a straight longitudinal direction, but twist and turn in eddies and at bends, so as to flow partly with the fast moving center and partly with the dragging water along the sides, the resultant being an evening-up to the average rate of travel. The results show that the last particles of color visible must have flowed at a rate of about nine-tenths that of the fastest, and this difference is intensified by the right-angled bend into the penstocks and the difference in length of path of the various particles in going through the turbines.

The fact that the point of maximum color occurs at the mean time between the first and last trace indicates that the greater proportion of particles have traveled at the mean rate. As the grading off of color was uniform and similar in both directions, it would appear that the time at which this maximum density occurs is the proper time to be used for computing the average rate of flow through the pipe. No proof of this is possible, without calibration by some more accurate method, if such exists; yet it is firmly believed to be near the truth.

At every opportunity this theory has been checked in one way or another, and no reason to doubt its correctness has as yet been found. On several of the slowest runs, rod floats were allowed to drift down the tailrace, and from the known volume the quantity was figured and found to check with that computed from the color. Again, the weir, which was a rather rough-topped concrete wall with an unknown coefficient, was calibrated by means of the color runs and the resulting discharge curve proved to be a true three-halves-power curve with a definite coefficient, in a general way showing the color method to be consistent within its range. As further checking by means of pipe losses and computed flow for different gate openings disclosed no error, it seems certain that very little error will result if this theory is adopted. In cases where a slight difference occurred between the mean of first and last traces and the time of maximum density, they were corrected according to the weighted probable degree of accuracy of observation, and averaged.

Proper Status of Color Tests

Substances other than aniline dye and permanganate have been tried out at various times but none has proved satisfactory. Shavings, sawdust, confetti and oil were experimented with at the Salmon River plant; but all are open to the same objection, that of dragging out the final traces to such a degree that all accuracy in the observation is lost and any recorded times are at least uncertain and indefinite. Where the water to be measured is clear and free from vegetable stain and the time of color-runs is not too great, potassium permanganate probably will prove the cheapest and most satisfactory substance to use, while in muddy streams or with long pipe lines affording sufficient time of transit for oxidation to take place, either a brilliant green or red aniline dye will be necessary.

In conclusion it may be said that if ordinary care is used to avoid unnecessary errors, if the color is introduced in the proper way and just enough is injected at a time to be clearly visible to the observer, the results obtained from color-run tests should have a higher degree of accuracy than those from the common methods of water measurement now in use, such as current meters, pitot tubes, rod floats, or even by the method of chemical solution; and will compare very favorably with results obtained from the standard test weir. Without doubt a carefully constructed sharp-edged test weir is the most accurate device for flow measurements; but in most cases it is impracticable to build one—either on account of the expense or the lack of a suitable location or because the quantity of water is too great to come within known experimental calibrations.

Color Test an Aid to Operation

With color, tests can be made conveniently at widely separated dates to determine the falling off of plant efficiency, the effect of any alteration or wearing of the waterwheel runners, etc.; whereas it is often most inconvenient to reconstruct a special weir during normal operation. For all such reasons it seems strange that this method is not more frequently used in connection with hydro-electric tests. It is applicable to any plant having a pipe line or long penstock, can be used without interruption to the commercial load, is inexpensive and with a moderate amount of care will give results that are sufficiently accurate for all practical purposes.

Roofs and Floors in Africa—Corrugated iron would seem on casual inspection to be the favorite roofing medium in Portuguese East Africa, but a tendency is manifest to replace it by materials more easily handled and at the same time less conductive of heat. United States Consul George A. Chamberlain, Lourenco Marques, believes that there is a promising market in his vicinity for modern roofings and floor coverings. Local builders state that pitch or asphalt or patented roofings are rapidly replacing old roofs. The floors in Lourenco Marques are of two kinds—in the cheaper houses of wood, and in the more expensive of parquet, tile or mosaic. The idea of the tile and mosaic floors is that they are cool; but at the same time they are tiring to the feet. Board floors, unless very carefully laid, give easy ingress to insects and vermin, which are very prevalent. Modern types of roofs have been introduced into Tripoli, Libya, since coming under Italian influence. Of the 1,050,000 inhabitants of Libya 95 per cent. are Arabs, and the largest portion of these are nomadic. Natives who live in the Oases haxe fixed habitations, with simple houses of stone ,sun-dried brick or packed earth, with roofs of date-wood rafters overlaid with palm leaves and straw and the whole covered with a coating of lime plaster. In coast towns the principal building materials are stone and brick, with flat roofs covered with lime concrete. Sloping roofs have now been introduced. A roofing that seems to have been favorably received is known as "Eternit" and is an artificial stone composed of asbestos, other mineral substances and chalk, mixed and hardened with acid. It is produced in sheets by an Italian firm at Casale Monferrato and costs about 5c. per sq.ft. This material can be cut without cracking, and nails can be driven through it. It is estimated that fully 75 per cent. of the $40,000 imports of roofing materials in Tripoli in 1913 were of "Eternit."

News of the Engineering World

New Carnegie I-Beams Rolled

An important change in its I-beam rolling is announced by the Carnegie Steel Co.—the production of a new line characterized by wide and thin flanges and flange bevel flattened to 1 in 11, the previous standard being 1 in 6. The sizes of I-beam to which this applies are 27, 24, 21, 18, 15, 12, 10 and 8 in. deep.

These beams are a development from the high-efficiency (thin-web) beams brought out a year or two ago. The introduction of the 27-in. size, and of the 21-in. size to replace the 20-in., was a feature of that line, as was also a tapered thickening of the web at its junction with the flanges. The new wide-flange line also has the 27-in. and 21-in. sizes, thus giving a 3-in. gradation down to the 12-in. depth and a 2-in. gradation thence to 8 in. In other respects, however, the new beams differ radically from the high-efficiency beams.

The webs are thicker, the flanges wider and much thinner, the flange bevel flatter, and the web-enlargement at the flanges reduced in size. The beams are all a pound or two heavier than the high-efficiency beams, and their carrying capacity per pound is lower (though equal to that of the "standard-weight" I-beams). The 24-in. I-beam, for instance, has 7-in. flange and ½-in. web in the old "standard-weight" section weighing 80 lb. per ft.; 7-in. flange and $^{25}/_{64}$-in. web in the high-efficiency section weighing 69½ lb.; 9-in. flange and $\frac{17}{32}$-in. web in the new section weighing 74 lb.

A pamphlet "Structural Beams," describing the new sections, has just been issued by the Carnegie Steel Co., Carnegie Building, Pittsburgh, Penn.

Organization of Pan-American Scientific Congress

A second Pan-American Scientific Congress will be held in Washington, D. C., Dec. 27, 1915, to Jan. 8, 1916. The program is divided into nine main sections, of which the fifth is Engineering and is in charge of Gen. W. H. Bixby. (The others cover anthropology, astronomy, natural resources, education, law, mining, public health and transportation.)

The secretary of the engineering section is Elmer L. Corthell. The section will concern itself in particular with discussion of various engineering subjects that commanded the attention of the delegates to the Santiago Congress of 1908. Among these is "a common Pan-American body of engineering nomenclature and laws regulating the use of water." Another subject to be discussed is the desirability and practicability of establishing a uniform railroad gage in Pan-America, especially in Central and South America. The five principal engineering societies of the United States have delegated their secretaries to represent them.—By G. L. Swigett, Assistant Secretary General, Second Pan-American Scientific Congress.

On the Pacific Coast Special

[*Editorial Correspondence*]

Members of the four national societies of civil, mechanical, mining and electrical engineers left New York City for San Francisco on Thursday, Sept. 9, on a special through train of 13 steel cars over the New York Central lines and Santa Fé system. The entire party, with those who joined at Albany, Buffalo, Cleveland and other points, numbered over 150.

Among the prominent members of the party were: Dr. John A. Brashear, President of the Mechanical Engineers, and William L. Saunders, President of the Mining Engineers; Gano Dunn, President of the United Engineering Society; H. J. E. Wenckebach and Robert Snellen, delegates from Holland to the International Engineering Congress; Major Jean de Pulligny, delegate of the French Government; Prof. A. E. Rohn, of the Zurich Polytechnic Institute, delegate from Switzerland; Roger Tappan, from Finland; W. Charnley, from Brazil; and José R. Villalon, from Cuba; Prof. Ira H. Woolson, S. L. F. Deyo, D. H. Grimm, C. F. Rand, Lazarus White, W. N. Best, Mansfield Merriman and J. J. Carty, of New York; Worcester R. Warner, of Tarrytown; H. G. Reist, of Schenectady; J. A. Seymour, of Auburn; Gardner Williams and C. F. Loweth, of Chicago.

Friday forenoon was spent at Niagara Falls, with a trip over the Niagara Gorge Ry. to Lewiston. Very hot weather prevailed the first two days, but heavy rains Friday night cooled the air and gave the travelers an opportunity to see the streams of northern Missouri and eastern Kansas in high flood.

Colorado Springs was reached on Sunday morning, Sept. 10. Most of the party spent the morning in an excursion by automobiles to Crystal Park, a mountain valley 2,750 ft. above the city plain. The park is reached by a new automobile road with 8% maximum grades. The road zigzags back and forth, and at three places, where the slope was too steep for grading wide enough to make a hairpin turn, a Y has been made. The company which built the road runs 20-passenger automobiles over it.

An excursion up Pike's Peak was attempted by most of the party in the afternoon, but the breakdown of the rack locomotive after the first half mile compelled a return. A number, by invitation of the Portland Mining Co., motored to Cripple Creek. Several others went over the new automobile road which is under construction to the top of Pike's Peak, and of which about 30 mi. has been completed.

Monday was spent crossing New Mexico, where remarkable sandstone cliffs were a source of great interest. The train arrived early Tuesday morning at the Grand Cañon of the Colorado River, and the visitors had the entire day to view this indescribable wonder.

Tuesday night and Wednesday were spent between the Grand Cañon and San Francisco, the most interesting

engineering feature being the famous Tehachapi Pass over the Sierra Nevada range. From the summit of the pass to Bakersfield, a distance of 50 mi., the railway descends 3,550 ft. The location is along steep hillsides where numerous tunnels and horseshoe curves and one complete loop were necessary.

At Albuquerque the travelers were greeted by a local committee representing the engineers of New Mexico; and as the train approached San Francisco on Wednesday afternoon, members of the local reception committee came out to extend a welcome. The remaining days of the week after arrival at San Francisco were occupied by the meetings of the several national societies, and the week following to the International Engineering Congress.

The Worst Slide at Gaillard Cut, Panama Canal, occurred on the east bank, just north of Gold Hill and directly opposite the village of Culebra, on Sept. 18. An upheaval of the bottom of the canal is alleged to have taken place at the same time, forming an island in the middle of the channel, closing the latter to navigation.

Reduction in Number of Accidents has been secured by the Baltimore Gas and Electric Co. as a result of the work of its safety committees. There were no accidents fatal to the public in the year ending June 30, 1915, and the total number of nonemployees injured was reduced from 102 to 25. However, four men were killed compared with one the year before. The total number of accidents was 330, a reduction of 30%; the number of employees injured was 301, or 17% reduction.

An Explosion Wrecked the sewage-pumping station of Batavia, N. Y., on Aug. 18, fatally injuring an employee and putting out of commission the pumps which lift the sewage of the city to sewage-treatment works. It is supposed that the explosion was caused by either natural gas or gasoline that gained access to the pump-well through the sewers. Thomas Fleming, Jr., of Chester & Fleming, Pittsburgh, was called in to advise the city immediately after the explosion. H. J. Burkhart is Mayor of Batavia.

A Large Contract for Stone Ballast for a portion of the new subway system for New York City has been awarded by the Public Service Commission for the First District. About 243,000 cu.yd. of hard-limestone ballast will be supplied by the Upper Hudson Stone Co. for $228,010, or about $0.94 per yd.

Grinding the Rails of Street Railways by means of the track brakes used on steep grades is being practised at San Francisco. The ordinary wood blocks or shoes of the track brakes are replaced by carborundum blocks and the cars are run at regular speed with the brakes set sufficiently to cause the blocks to grind the rail heads.

Railway Scale-Testing Cars of large and short wheelbase were discussed by C. A. Briggs, of the United States Bureau of Standards in a paper read at the Chicago meeting of the National Association of Scale Experts. His conclusions were unfavorable to the longer double-truck cars and in favor of four-wheeled cars. The wheelbase preferably should be 5 or 5½ ft., with 7 ft. as a maximum.

The First Cargo of American Coal for Greece was shipped from Norfolk, Va., in July. The collier proceeded to Patras where 3400 tons was discharged, then to Parræus, where the remaining 2600 tons was discharged. The price of the coal is stated to have been $15.07 per ton c.i.f. Patras, of which $11.42 was for ocean freight and $3.65 for the coal itself. The annual consumption of coal for the Patras district is 60,000 to 80,000 tons, practically all bituminous.

A Weather Bureau Station has just been established on a farm near Omaha, Neb., for the purpose of making systematic observations of the upper air, by means of kites carrying self-recording instruments. It was not necessary to erect new buildings, excepting a small shelter for the kite reel, as the buildings on the farm were sufficient for the needs of the work. This work was formerly carried on at Mount Weather, Va., and the apparatus was moved from that station to the present one. This station will be known as the Drexel Aërological Station, and the observations obtained here will be sent to the Central Office of the Weather Bureau at Washington, D. C., for computation and study. Kite flights were begun at this station Sept. 1.—B. J. Sherry, Drexel, Neb.

The Largest Municipal Office Building in the world is the new Municipal Building of New York City. According to the report of Borough President M. M. Marks, the building contains about 1,000 offices, which are occupied by over 4,2[illegible] city officers and employees. The force employed for cleaning, maintaining and operating the building is under the 8-h[illegible] law and other restrictions, which make it difficult [illegible] secure economy. Nevertheless, the estimated annual cost f[illegible] daily cleaning, watching and attendance for 1915 is on[illegible] 11.9c. per sq.ft. There is in the entire building 830,000 sq.[illegible] of floor area. The estimated total cost of operation and mai[illegible] tenance for 1915, including heating, lighting and elevat[illegible] service, is 29¾c. per sq.ft. of floor area and 49c. per sq.ft. [illegible] office area.

Shipbuilding in Nagasaki, Japan, has become an industry of great importance since the opening of the Panama Canal and the withdrawal of many European vessels from active service. Although Oregon pine costs 70 to 75 per cent. more than the native pine, it is preferred for shipbuilding purposes because of its fewer knots and more regular grain. These characteristics result in a reduction of labor cost, which is an important factor in Japan, where the cost of labor is high compared with other places in the Far East. The Japanese ship's carpenter receives the equivalent of 30c. to $2 per day, according to his degree of skill, while in certain parts of China an expert carpenter receives less than 10c., United States currency. The largest single shipment of Oregon pine to Nagasaki is now on its way and consists of 2000 tons of timber.

A Large Coal-Loading Wharf is under construction in New Castle Harbor, New South Wales. It will be one-third mile long, with water 30 ft. deep along the face line. A system of heavy diagonal bracing is employed between the superstructure and the high-water mark, for the purpose of preventing the traverse rail from being knocked out of alignment by heavy vessels. The dock will carry six 15-ton coal-loading high-speed electric traveling cranes, each weighing 200 tons, of English manufacture. Two have been delivered, and a third is on the way. The following data are from a report on the test of these machines:

Hoisting with two motors: Load, 15 tons; speed, 97 ft. per min.; 480 volts, 240 amperes. Hoisting with one motor: Load, 15 tons; speed, 47.6 ft. per min.; 270 volts, 110 amperes. Traveling: Speed, 97 ft. per min.; 488 volts; 48 amperes.

For hoisting, 154 hp. was required; 7¾ hp. for slewing, and 31½ hp. for traversing. Each of the cranes will lift 15 tons at 55-ft. radius a vertical distance of 39 ft. It is estimated that the six cranes will be able to load over 2,500,000 tons of coal per annum.

PERSONALS

Mr. R. S. Bryant, Consulting Engineer of the Standard Welding Co., of Cleveland, Ohio, has become Factory Manager of the company.

Mr. Joachim G. Glaver has opened an office in the Railway Exchange Building, Chicago, Ill., where he will engage in structural engineering.

Mr. Charles L. Wood, formerly with the United States Coast and Geodetic Survey, has been appointed Highway and Bridge Engineer of Lowndes County, Mississippi.

Mr. Thomas B. Smith, formerly Postmaster of Philadelphia, has been appointed a member of the Public Service Commission of Pennsylvania by Governor Brumbaugh.

Mr. F. K. Bennett, Supervisor of the Minneapolis & St. Louis R.R., at Monmouth, Ill., has been made Valuation Engineer, with headquarters at Minneapolis, Minn.

Mr. Gus E. Hauser, Jr., of Columbus, Miss., has been appointed consulting engineer for the $100,000 bond issue for highway construction in Lowndes County, Mississippi.

Mr. Charles A. Russell, of Gloucester, Mass., has been appointed a member of the Massachusetts Public Service Commission, to fill the vacancy caused by the retirement of Mr. Clinton White.

Dr. Otto Kress will hereafter have charge of the pulp and paper investigations at the United States Forest Products Laboratory at Madison, Wis. He succeeds Mr. O. L. E. Webber, who recently resigned.

Mr. Herman L. Wittstein, Jun. Am. Soc. C. E., Efficiency Engineer of the Knox Motors Co., Springfield, Mass., has become Assistant to the Manager of the Standard Fuse Corporation at Paulsboro, N. J.

Dr. Robert P. Calvert, Instructor of Chemistry at Columbia University, has been appointed Director of the Laboratory of

General Chemistry at the Experiment Station of the E. I. du Pont de Nemours Powder Co., of Wilmington, Del.

Mr. Charles B. Buerger, M. Am. Soc. C. E., Principal Assistant Engineer with Mr. George W. Fuller, New York City, has resigned to accept an appointment as Consulting Engineer of the Atlantic Refining Co., of Philadelphia, Penn.

Mr. J. P. Walker, Assistant Engineer of the Valuation Department of the Atlantic Coast Line at Petersburg, Va., has been made Assistant Superintendent of the Charleston district of that road, with headquarters at Charleston, S. C.

Mr. Nelson Ogden, Assoc. M. Am. Soc. M. E., who was engaged for a number of years with the New London Ship and Engine Co. on the design of Diesel oil engines, has accepted a position with the McIntosh & Seymour Corporation, of Auburn, N. Y.

Mr. William C. Coffin, M. Am. Soc. M. E., recently Structural Engineer of the Jones & Laughlin Steel Co., Pittsburgh, Penn., has been elected Vice-President of the Knox Pressed & Welded Steel Co., Pittsburgh. From 1898 to 1908 he was Vice-President of the Riter-Conley Manufacturing Co.

Mr. Edward Anderberg, Assoc. M. Am. Soc. C. E., Assistant Engineer, New York State Barge Canal, in charge of bridge and lock work, at Lockport, N. Y., has been appointed Resident Engineer at New York City, in charge of terminal construction. He succeeds Mr. Earl Talbot, who recently resigned.

Prof. Frederick H. Newell, M. Am. Soc. C. E., the new head of the civil engineering department of the University of Illinois, and formerly Director of the United States Reclamation Service, has been appointed a member of the Illinois State Board of Examiners of Structural Engineers, by Governor Dunne.

Prof. Alexander Miller Gray, Assistant Professor of Electrical Engineering at McGill University, Montreal, has been appointed Professor of Electrical Engineering in Sibley College, Cornell University. He will also be the head of the electrical department, filling the vacancy caused by the resignation of Prof. H. H. Norris.

Dr. M. X. Sullivan, who has been connected with the Division of Soil Fertility of the United States Department of Agriculture, at Washington, D. C., has accepted the position of biological chemist of the United States Public Health Service. He will be engaged in the biochemical study of pellagra at the pellagra hospital in Spartanburg, S. C.

Mr. William E. Keily, Assoc. Am. Inst. E. E., until recently Associate Editor of the "Electrical World," at Chicago, has opened an office in the Edison Building, 72 West Adams St., that city, where he will engage in consulting work in public-utility development. From 1910 to 1914 Mr. Keily was Editor of the "Convention Daily," published at the annual conventions of the National Electric Light Association held at St. Louis, New York, Seattle, Chicago and Philadelphia. Previous to his connection with the "Electrical World," he was Managing Editor of the "Western Electrician" of Chicago.

OBITUARY

Sereno S. Pratt, of Brooklyn, N. Y., for the last five years Secretary of the Chamber of Commerce of New York City, died recently at his summer home at Dorset, Vt.

Charles Hawlett Wing, Professor and head of the Department of Chemistry of the Massachusetts Institute of Technology from 1874 to 1884, died in Boston on Sept. 14, at 80 years of age. He was Professor of Chemistry at Cornell University previous to his connection with the Technology.

Gen. Edward H. Ripley, founder and Director of the United States and Brazil Steamship Line, died at Rutland, Vt., on Sept. 14, after a long illness. He was the builder of the Raritan River R.R. and various structures in New York City. He left Union College to enter the Union army as captain of volunteers and was rapidly promoted to the rank of brigadier-general.

William F. Fitch, formerly President of the Duluth, South Shore & Atlantic R.R., died at his home in Marquette, Mich., on Sept. 16, at 76 years of age. Mr. Fitch was born in Circleville, Ohio, and in 1871 began his railroad career as a clerk in the employ of the Chicago & Northwestern Ry. In 1888 he entered the service of the Duluth, South Shore & Atlantic. At various times he was also President of the Mineral Range R.R., General Manager of the Calumet & Hancock R.R., and President of the Lake Shore Terminal & Transfer Ry. In 1902 he became Vice-President of the Wisconsin Central Ry.

John Howard Van Amringe, Dean Emeritus of Columbia College, died at the age of 79 years at the Keeler House, Morristown, N. J., on Sept. 10, from a stroke of apoplexy. He was born at Philadelphia, and received his education at the Montgomery Academy, in Orange County, N. Y., Yale and Columbia colleges. He devoted almost his entire time for fifty years to the interests of Columbia, and retired only five years ago. He was the author of a "History of Columbia College" and contributed the Columbia section to the volume known as "Universities and Their Sons." Some years ago he edited a series of Davies' mathematical works; at one time he was president of the New York Mathematical Society.

ENGINEERING SOCIETIES

COMING MEETINGS

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 19-21. Annual meeting, at Detroit, Mich. Secy., C. A. Lichty, 319 N. Waller Ave., Chicago.

SAN FRANCISCO MEETINGS

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30. A. C. Carruthers, Vice-Pres., Collective Insurance & Universal Safety Exhibit, Mines and Metallurgy Bldg., San Francisco.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

National Conference on Concrete-Road Building—This meeting will be held in Chicago, Feb. 15-18, 1916. The notice in the issue of Sept. 9 gave the date as Sept. 15-18.

The Society to Promote the Science of Management will hold a special memorial meeting in honor of Frederick W. Taylor on Oct. 22, at 8:15 p.m., in Houston Hall, University of Pennsylvania, Philadelphia. There will be several speakers who have been closely associated with Mr. Taylor at different periods of his career. The secretary is Prof. Henry W. Shelton, Hanover, N. H.

Electrical Dealers' and Contractors' Association of Ontario—The annual convention was held in Toronto, Can., Sept. 6-9. The following officers were elected: President, J. W. Commeford, Toronto; First Vice-President, William Greenleaf, Belleville; Second Vice-President, J. R. Zenorbie, Windsor; Secretary, Rufus Earle, Toronto; Treasurer, J. C. Soules, Toronto. The place of meeting for next year was left to the decision of the Executive Committee.

Northwestern Branch of the American Society of Civil Engineers—The Northwestern Branch held its annual meeting on Sept. 17 in St. Paul, Minn. After a dinner the following officers were elected: President, W. L. Darling, Chief Engineer of the Northern Pacific Ry., St. Paul; First Vice-President, George L. Wilson, Chief Engineer of the Twin City Rapid Transit Co., Minneapolis; Second Vice-President, L. W. Rundlett, St. Paul; Secretary, R. D. Thomas, Minneapolis; Treasurer, A. F. Meyer.

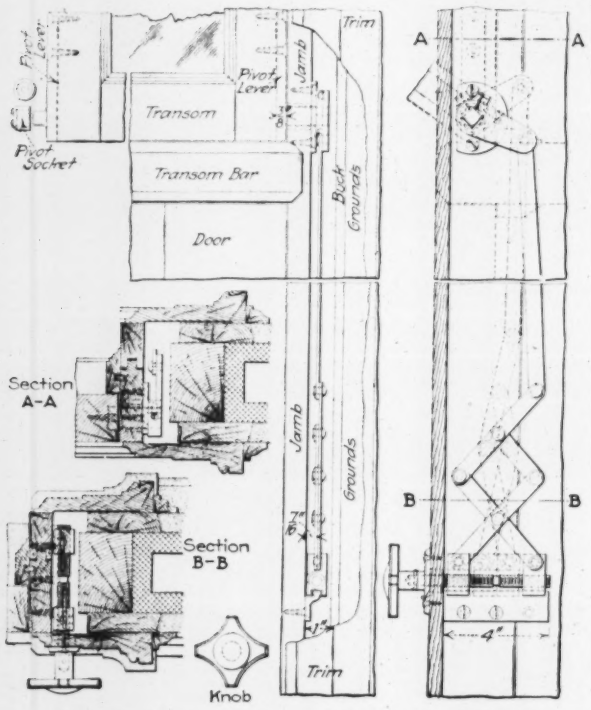
Institute of Paving Brick Manufacturers—This society was recently organized with the following officers: President, F. R. Kanengeiser; Vice-President, D. E. Humphrey; Secretary, Robert Keplinger, Metropolitan Paving Brick Co., Canton, Ohio; Treasurer, Spencer M. Duty. A meeting was held at Alton, Ill., on Sept. 22. This society was organized for the benefit of brick makers, men and companies of allied occupations being admitted only to associate membership. Only active members constitute the board of directors. Officers must be active members and no two of them can be identified with the same concern. The dues of an active member are $20 per year, while an associate member pays $5 per meeting

The American Institute of Consulting Engineers is the first engineering organization to join the Chamber of Commerce of the United States. The Institute will coöperate with the Chamber in its activities for the development of industry and commerce. The Institute is the only engineering organization that has membership in the Chamber.

Appliances and Materials

Concealed Transom Operator

A new type of concealed transom operator involving no gears, bolts or exterior rods is being installed in some of the newer buildings. The design comprises lazy tongs, a reach rod and a bell crank as shown in the accompanying sketch. The first complete turn of the operating knob noiselessly opens the transom to an angle of 20 deg. This operator is for bottom-, center- or top-hung transoms and is adjustable to every style and size. The maker, the Tabor Sash & Fixture Co., 61 Polk St., Newark, N. J., claims that the device requires no oiling or attention after installation and that the working parts are rust-proof. The entire device can be removed by loosening the screw on the top clamping level after the trim is removed.



NEWBERTH CONCEALED TRANSOM-OPERATOR

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An Electric Harbor Range Light, made by the Esterline Co., of Indianapolis, and known as the "Golden Glow" light, has been installed by the United States Lighthouse Bureau at Vidal Shoals, at Two Harbors and at other points on the Great Lakes, and is shortly to be installed in the Philadelphia harbor. In this light a deep parabolic reflector is used, made of glass of a yellowish green color. The silvering is done on the outer surface of the reflector. The light from the lamp passes through the glass and is reflected back again from the silvered surface; the blue and violet rays are absorbed, and the yellow rays which are reflected are claimed to have special power to penetrate fog. Similar reflectors are made for locomotives, electric-railway cars, searchlights, etc. In the harbor range lights 94- to 151-watt incandescent tungsten lamps are used.

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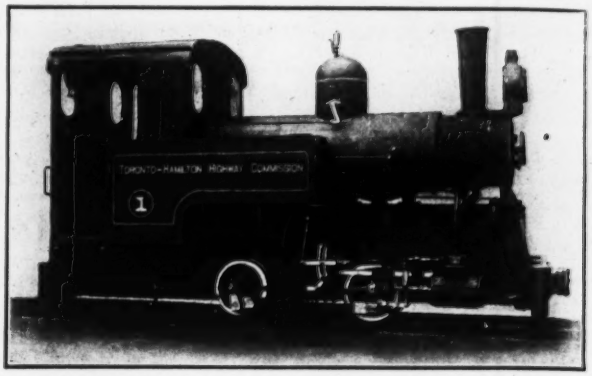
Dinkey Locomotive with Underhung Tank

The interesting type of dinkey locomotive shown herewith is one of three built by the H. K. Porter Co., of Pittsburgh, Penn., for the Toronto-Hamilton Highway Commission for use on road construction. The special features are the use of plate frames and the utilization of these frames to form the sides of an underhung water tank, forward of the firebox. This gives a lower center of gravity than can be obtained with a saddle tank over the boiler, and results in greater steadiness on rough tracks.

The engine is for track of 24-in. gage. While it weighs only 7½ tons, it has a tractive effort as high as 3435 lb. It



DINKEY LOCOMOTIVE WITH PLATE FRAMES AND UNDERHUNG TANK

is 14½ ft. long, 8 ft. wide, and 8½ ft. high overall. The cylinders are 7x10 in., with slide valves and the Walschaerts valve gear. The driving wheels are 20 in. diameter, with a wheelbase of 4 ft. The boiler is 25 in. diameter, and carries a pressure of 165 lb. A coal bunker of about 500-lb. capacity is placed at one side of the boiler.

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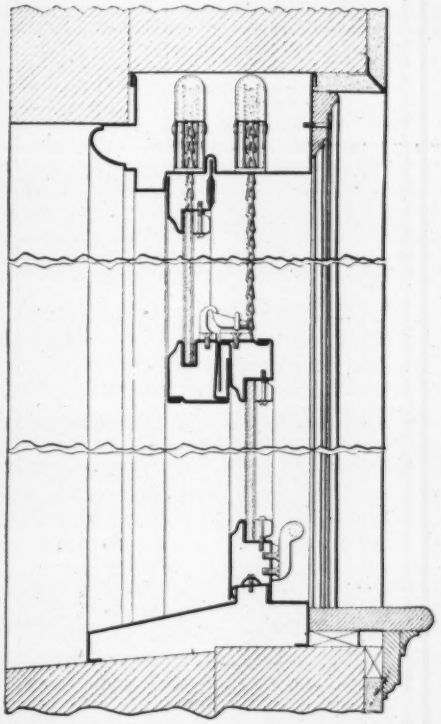
Heavy Double-Hung Window

A new steel street-front window is manufactured by the S. H. Pomeroy Co., Inc., New York City, which is three times as heavy as the usual fire-retardant windows produced by this company. It can be supplied with either single- or multi-light sash, with or without glass in place. Wearing parts are replaceable. The details of the double-hung window are shown in the accompanying cross-section drawing. The window is applicable to office buildings, loft buildings, hotels and apartment houses.



FIREPROOF WINDOW FOR STREET FRONTS

Engineering News

VOLUME 74 SEPTEMBER 30, 1915 NUMBER 14

Rebuilding Elevated Railways in New York City—I

SYNOPSIS—Adding a third track for express service on the elevated railways of Manhattan and Bronx boroughs, New York, made extensive rebuilding of the structure necessary. The work involves about 50,000 tons of steel, and had to be done under traffic. Different station types are used, the principal ones being the mezzanine and hump type.

Most of the 37-mi. network of rapid-transit elevated railway in the Boroughs of Manhattan and Bronx, New York City, all originally built double-track, is being reconstructed by adding a third track for express-train service. Some lines were equipped with a third track a number of years ago, notably the Ninth Ave. line, on which expresses have been operated since that time in a no-stop run from 14th St. to 116th St., about five miles. This early third-tracking, however, has little effect in reducing the magnitude of the present enterprise, because the work, while primarily consisting of adding a track to the elevated structure, involves a great deal more:

Complete or nearly complete replacement of present two-track structure at certain locations by new structure carrying from three to five tracks; removal of all present center platforms, so as to permit the carrying through of the center track; remodeling a large number of stations to serve the express traffic, which generally includes reconstruction of structure for a distance of about 1700 ft.; replacement of a two-track swing span and two end spans with a double-deck four-track bridge; and rearrangement of running tracks, at one point even raising the running tracks 7 ft. and at another shifting the track with its supporting girders 13 ft. sidewise; all the work be-

FIG. 1. DOUBLE-DECKING THE SOUTH FERRY LINE IN NEW BOWERY, MANHATTAN BOROUGH, NEW YORK CITY

FIG. 2. ELEVATED-RAILWAY SYSTEM OF THE BOROUGHS OF MANHATTAN AND BRONX, NEW YORK CITY

ing accomplished without interfering with the proper running of the trains, which carry over one million passengers a day.

Complicating the whole problem, three important grade crossings or track junctions are being rebuilt with separation of grade and routes, involving much new structure, double-decking, revision of trackage, etc.

The undertaking is of such magnitude that it may be considered virtually a reconstruction of the entire elevated system of the Manhattan Railway Co. The work is described in a summary way in the present article. The reconstruction is being carried out by T. A. Gillespie Co., Terry & Tench, and Snare & Triest, contractors, under the supervision of the Interborough Rapid Transit Co., lessee of the Manhattan Railway Co. lines under a 999-year lease. The plans for the work received the formal approval of the Public Service Commission, but were developed wholly in the Interborough engineering department.

Planned Fifteen Years Ago

A dozen or more years ago the Manhattan Railway Co. entertained the idea of fitting all its lines with third track for express-train operation—southward in the morning rush hours, northward in the evening rush hours, express trains in both cases to return over the local tracks. The feasibility of the project was investigated at that time, the old structure and its possibilities in the way of carrying additional loads and suitability for reinforcing were thoroughly canvassed, and designs were developed for a considerable part of the work. However, for various reasons the work was not carried any farther then.

Five years ago, when the city authorities in negotiating for new rapid-transit construction asked for inclusion of third-tracking proposals, the plan was taken up anew. The agreement between the city and the Interborough, reached in March, 1913, included the third-tracking of the elevated lines as an essential feature. Not long afterward the Public Service Commission issued formal authorization for the work, which has been carried forward actively since then to the point where erection is in progress on practically every section of the undertaking.

Work Done Under Traffic

The most important condition of the work was that the dense traffic—averaging about 300 trains per day per track—must be maintained at all times, without interruption or risk, and with the minimum inconvenience to passengers and disarrangement of schedules. This meant piecemeal work, the adoption of cutting and fitting methods in place of complete reconstruction in many instances, and sometimes the adoption of radically unusual designs or procedures.

On the map, Fig. 2, the four lines in Manhattan, one of them extending into Bronx Borough, are indicated. Each of the four lines was double-track, except for three tracks on the Ninth Ave. line from 12th St. to 159th St. (between 114th and 127th St. there were only two tracks), and on a portion of the Third Ave. line. As reconstructed, the system will have three tracks everywhere except on the Sixth Ave. line, and four or five tracks in the vicinity of the Chatham Square junction and between 125th and 145th St. on the Second Ave. and Third Ave. lines.

Other prominent elements of the system as rebuilt are: Station reconstruction on the remainder of the Ninth Ave. line north of Christopher St. to suit the new express-operating system; double-decking along Park Row on the Third Ave. line to provide four tracks entering City Hall station from Chatham Square station, and similar double-decking on the Second Ave. line from Franklin Square to Chatham Square station to correspond with the

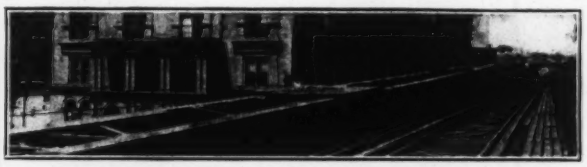


FIG. 3. TRACK INCLINE TO "HUMP" EXPRESS STATION, NINTH ST. STATION OF THIRD AVE. LINE

FIG. 4. MEZZANINE CONCOURSE OF ISLAND-PLATFORM STATION, 42ND ST. STATION OF SECOND AVE. LINE

elimination of grade crossing at Chatham Square; complete rebuilding and double-decking of Chatham Square station to separate crossing tracks; rebuilding the entire structure for five tracks to near Canal St. and for three tracks north of this point; third-tracking and station revision northward on Third Ave. to the Harlem River bridge; third-tracking and provision of express stations on the Second Ave. line from Chatham Square to 125th St., and removal of the 127th St. station to 125th St.; revision of track and double-decking thence north to Harlem River bridge; replacement of the entire Harlem River bridge by a double-deck structure, giving four tracks total; four-tracking and station revision to 145th St. in the Bronx, and third-tracking thence north to the end of the line at Bronx Park.

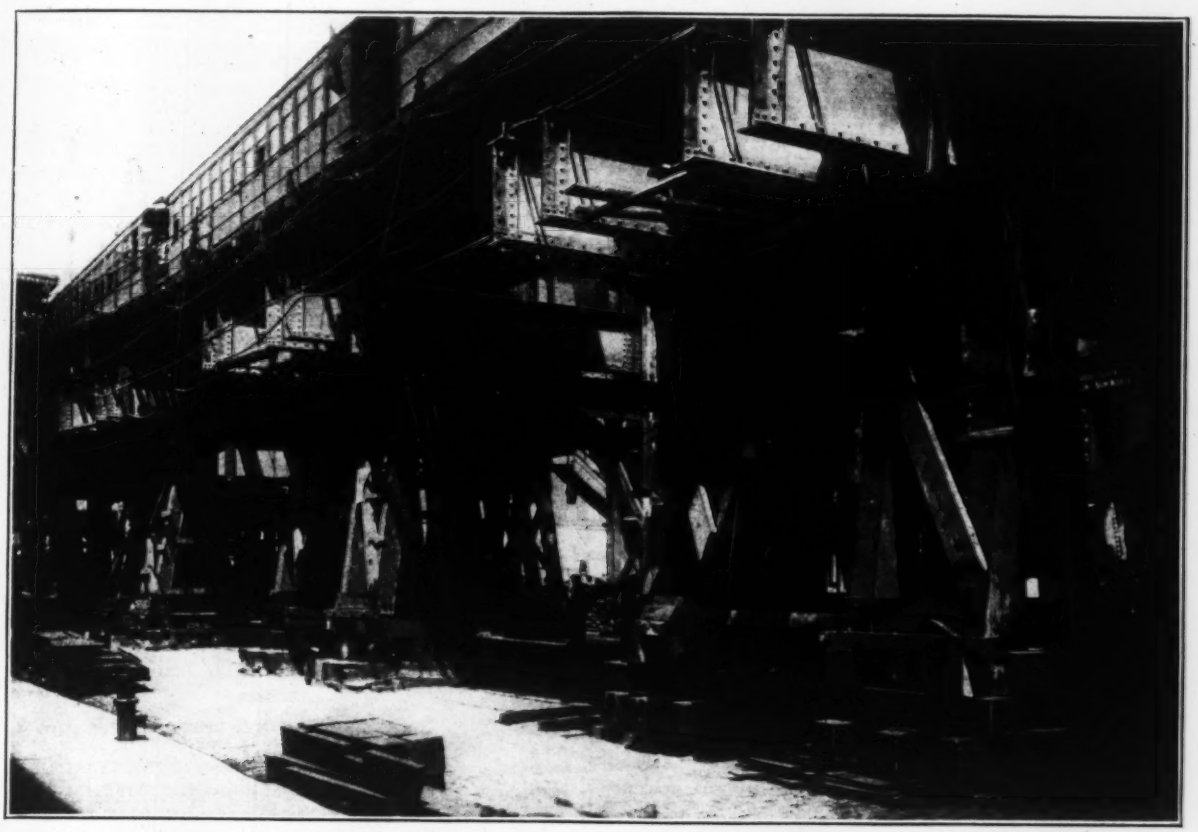


FIG. 5. TYPICAL SHORING WITH NEEDLE BEAMS; ELEVATED-RAILWAY RECONSTRUCTION
Needle beams required here for supporting center-track girders

General Conditions of Reconstruction

Most of the old elevated structure consists of transverse bents comprising two columns and a plate-girder or truss, spaced generally 42 to 45 ft. apart along the line, carrying longitudinal girders—one per rail—on which the track ties are laid. At individual points where the structure is high above the street successive pairs of bents are braced together by longitudinal portal bracing to form four-column towers.

Most of this two-column construction had been built originally with tracks spread sufficiently to admit a future center track. In some places the cross-girders of the bents had even been punched for the connection of the future track girders. However, on parts of the line the cross-girders were not strong enough to carry the additional track with modern loading—the present-day electric elevated trains, as compared with the much smaller and lighter cars and light steam locomotives of twenty years ago. It was necessary to remove these girders and replace them by stronger ones, and in many cases also to renew the columns.

Single-Track and One-Column Construction

Single-track or one-column construction (see sketches E and J, Fig. 6) existed on a few lines, notably on the Bowery and New Bowery (Third Ave. line) and on Greenwich St. (Ninth Ave. line). The columns, set just inside the curb line, on the sidewalk were built with a spread cap carrying a pair of track girders of suitable spacing for one track. In some instances the two single-track structures, one on each side of the street, were braced together by transverse struts, but in the main they relied for lateral stiffness upon the fixity of the columns on their brick foundation piers.

The treatment suitable for the several cases of single-track construction depended upon the layout of the new work. Throughout the length of the Bowery it has been necessary to build an entirely new structure occupying the middle of the street and to abandon the old structure completely with only local exceptions, where the original column locations could be used. On Greenwich St., however, the old column locations and in fact many of the

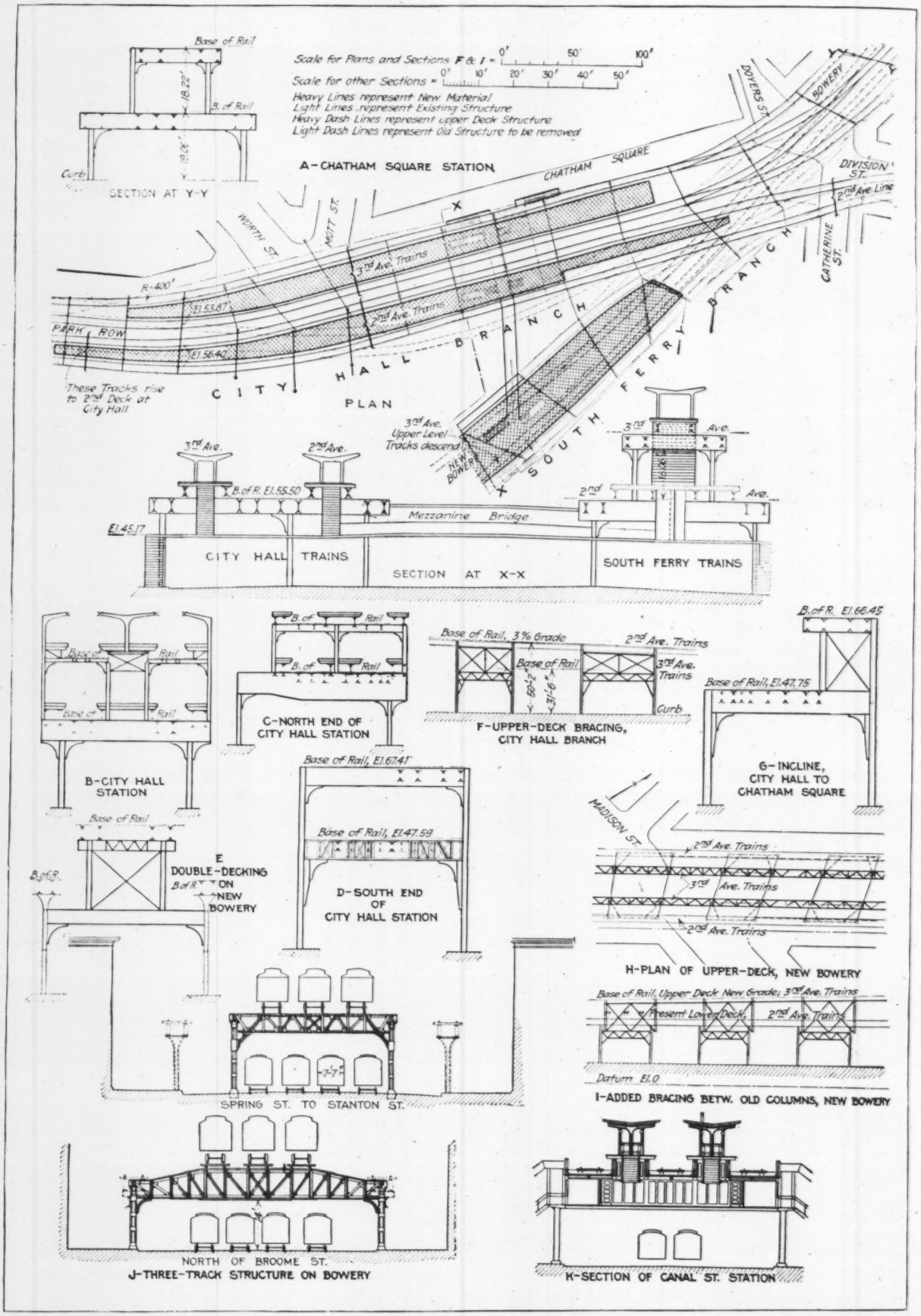


FIG. 6. TYPICAL SKETCHES OF NEW YORK ELEVATED-RAILWAY RECONSTRUCTION, SOUTH PORTION

old columns themselves are retained throughout and cross-girders are slipped in between the old track stringers, carrying them as well as the new set of middle track girders. When the new work is completed there will be none of the single-column structure remaining in service.

Express Stations: Mezzanine and Hump Types

How to reach the new center track with station platforms (at express stations) was one of the essential problems of the enterprise.

Two main types of station were worked out as solutions of this problem—(1) the island-platform or mezzanine station type, and (2) the double-deck station or "hump" type.

(1) The island-platform stations, in which the platforms are between the tracks and are reached by stairs, have the station booths and concourse on a mezzanine floor between street and track level. Sketch A in Fig. 6 and the view, Fig. 4, show such stations.

This type was used where the tracks were far enough apart or could be spread to admit the island platforms. The structure was high enough, at most of the stations, to admit of building the mezzanine floor and yet leave sufficient street clearance; but at several stations the structure had to be raised to make room for the mezzanine, by amounts ranging up to 7 ft.

(2) The "hump" type of station, produced by raising the center track about 11 ft. at and near the station, with express platforms located directly over the local tracks, and local platforms outside the local tracks, has an important advantage in not requiring more width of ground area than the previously existing local station. Also, it is the cheapest solution where the center track already exists or where the existing structure is wide enough only for third track without island platforms. The circumstances of the old elevated structure were such that the hump type proved best for a number of locations—see for example the view, Fig. 3.

A determining factor in deciding between mezzanine and hump station was the matter of easement damages to abutting property. Where there was reason to apprehend large claims for damages if the elevated structure were widened for island platforms, the hump type was adopted, as involving least disturbance of the property status.

The principal station type other than the two above noted is that employed at Greenwich St., on the Ninth Ave. line. Here the old tracks were spaced far enough to admit a third track and a single island platform—the old outside platforms being continued in service. However, the structure was not high enough to admit a mezzanine for reaching the express (island) platform. Therefore a bridge over the tracks was constructed, with stairs to all three platforms, allowing access to the island platform from either local platform.

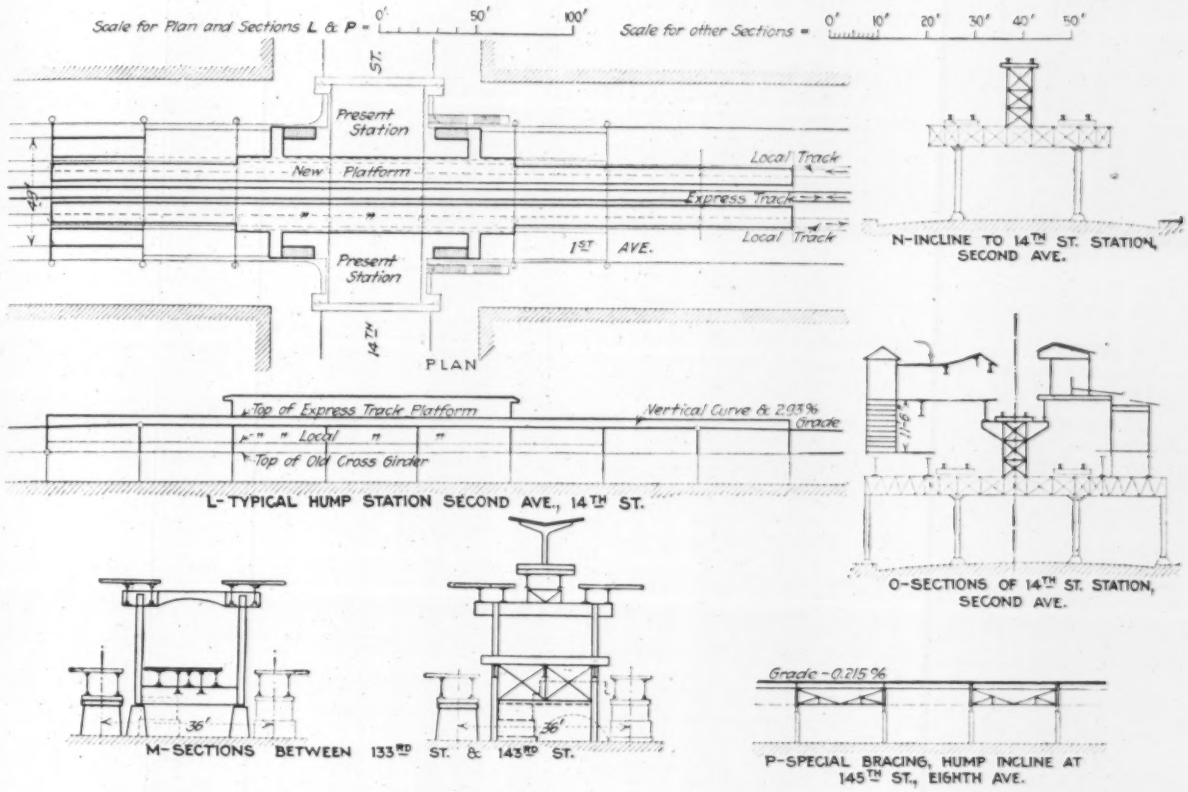

Scale for Plan and Sections L & P = 0' 50' 100'
Scale for other Sections = 0' 10' 20' 30' 40' 50'
Present Station
New Platform
Local Track
Express Track
Local Track
1ST AVE.
Present Station
PLAN
N-INCLINE TO 14TH ST. STATION, SECOND AVE.
Top of Express Track Platform
Vertical Curve & 2.93% Grade
" " Local " "
Top of Old Cross Girder
L-TYPICAL HUMP STATION SECOND AVE., 14TH ST.
O-SECTIONS OF 14TH ST. STATION, SECOND AVE.
36'
36'
M-SECTIONS BETWEEN 133RD ST. & 143RD ST.
Grade -0.215%
P-SPECIAL BRACING, HUMP INCLINE AT 145TH ST., EIGHTH AVE.

FIG. 7. HUMP STATION CONSTRUCTION AND DOUBLE-DECK WORK ON BRONX BOROUGH ELEVATED LINES.

An Ingenious Station Arrangement

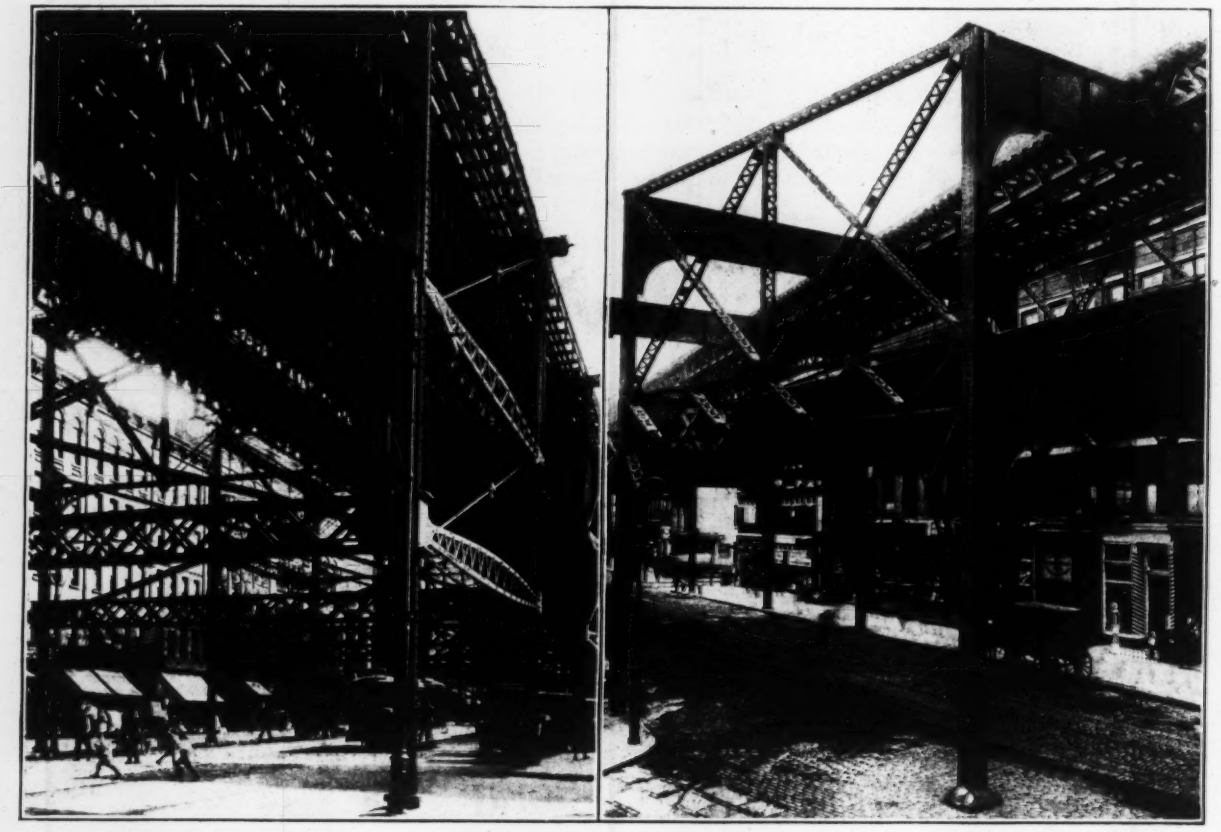
An ingenious special arrangement of station platforms was used in rebuilding the 116th St. station of the Ninth Ave. line. Here also only one island platform could be placed between tracks, but there were no outside platforms and no possibility of placing them. An island platform was therefore arranged between the southbound track and the express track, here shifted close over toward the northbound track; just north of this platform the express track was swung over to a position alongside the southbound track, and beyond this point a second island platform built

between the express and northbound track. The mezzanine station communicates with both platforms and connects them.

Shoring the Structure for Rebuilding

The simple hoisting and setting of new center track girders is carried on entirely from above by a derrick traveler sliding on the finished track and with sufficient reach to erect the span ahead and (in cases where there is an upper-deck structure) the next succeeding bent, and of sufficient capacity to lift from the street or from a construction car on one of the running tracks and set to place in the span ahead one of the new track stringers. However, as there is such a large amount of work involving changes in or replacement of old structure, the general condition is that shoring from the street surface is required as a preliminary to the center-track work.

Difficulties in the way of shoring are the presence of double-track street-car lines in all the streets on which elevated structure exists, and the fact that the clearance height of the old structure is so low that the depth available for needling girders is quite limited. The type of shoring most commonly employed, illustrated by Fig. 5 (Third Ave. near 42nd St.), comprises square towers made up of four 12x12's set in a 5-ft. square, adapted to be set directly on the street pavement and form a seat for blocking and jacks about 3 ft. below the bottoms of the track girders. At each column where shoring support is required two such towers are used, one being set just forward and the other just back of the column, directly under the outer pair of track girders, and so as to clear the street-car tracks. With towers thus placed at two columns of the bent, blocking placed on the four tower-supports the four girder-span ends and enables the track girders to be jacked up, the cross-girders to be removed and replaced, and the columns to be renewed. Where towers could not be placed to give direct support, or where a center track also had to be supported, transverse I-beams bearing on a pair of towers were placed under the track girders.



FIGS. 8 AND 9. SPECIAL BRACING OF RECONSTRUCTED ELEVATED-RAILWAY STRUCTURES IN MANHATTAN

Fig. 8—Additional bracing of high structure on the Ninth Ave. line at Eighth Ave. and 117th St. On both transverse and longitudinal bracing of the towers, the lower panel has been added. Note gusset-plate connections to Phœnix columns. Fig. 9—Tower bracing of double-deck structure on Park Row

Removing and Resetting Cross-Girders

At some locations the cross-girders after being cut loose from their connecting track-girders can be slipped out endways and removed, all interfering stiffeners being cut away to make this possible. In many cases, however, the cross-girder has to be cut into three pieces—cutting loose the center section and lowering it into the street, and then slipping out the two end sections. The cutting is in nearly all cases done by oxyacetylene burners.

Erection of the new cross-girders is done either by slipping in the two ends from the sides and lifting up the center section from the street and splicing, or by lifting the girder up straight in one piece, its top flange being left off to be put in place after the girder is set.

(Concluded in next week's issue)

Water-Typhoid Suit Lost

A suit to recover $15,000 damage for a death from typhoid fever alleged to have been caused by polluted water due to a faulty check valve between a mill supply and the supply furnished by the Circleville Water-Supply Co., of Circleville, Ohio, was decided in favor of the company early last May. Although the decision was in a petty court and can in no sense be regarded as laying down the law in Ohio or elsewhere, the alleged facts in the case and some of the instructions given to the jury by the presiding judge seem worthy of record.[1] The following notes have been taken from a summary of the testimony prepared by Barton Walters, of Circleville, Ohio, counsel for the water company.

According to the testimony, there was only one death from typhoid fever in Circleville during the 3¾ yr. ending with September, 1913. Changing now from deaths to cases, the testimony indicated one case in October, one in November, two in December, 1913, 14 in January, 1914, 20 in February of the same year, and after that scattering cases which brought up the total to 54 cases. There were five deaths. An investigation of 43 cases by the Ohio State Board of Health showed that these were distributed among 40 families containing 178 persons; two cases were probably due to contact, and one case was contracted outside of the city. There seemed to be no connection between the outbreak and the milk supply, the State Board of Health concluded. It appeared that 70% of the families affected used unsanitary privies [it should be noted, however, that the outbreak was in the winter], but the company's water-supply was in general use, and while wells and cisterns were common, water from these was not used for drinking purposes.

The husband of the deceased brought suit for damages, alleging that it was the duty of the Circleville Water-Supply Co. to furnish pure and wholesome water, and that the company had disregarded this duty, negligently permitted the water-supply to become contaminated and thus caused the death of his wife. The alleged cause of this pollution was not the regular supply of the Circleville Water-Supply Co., but water from the Scioto River, which, it was claimed, gained access to the mains of the water company through an emergency connection between the fire-protection water-supply system of a large paper mill of Circleville and an emergency connection between this supply main and the water main of the Circleville Water-Supply Co. According to the summary of the testimony prepared by Mr. Walters:

> This connection was made between the sprinkler system of the mill and the mains of the Circleville Water-Supply Co. by installing an 8-in. Pratt & Cady check valve with an automatic swinging gage. This valve was installed, it was claimed, eight or ten years ago, and was so arranged that the water could pass from the mains of the public utility to the mains of the industrial plants whenever the pressure in the industrial plant was lower than that in the city mains.

The defendant company tested the valve from time to time by means of a water meter set in a rubber-hose bypass, relying upon the meter to show water passing in either direction after closing the manually operated gage set at the connection. Quoting again from Mr. Walters' summary of the testimony:

> It was claimed that in January, 1914, this test as described was made and that it was discovered that a considerable quantity of water from the mains of the paper mill was passing back through the check valve into the mains of the water company. A trench was opened in the street and the valve uncovered, and upon removing the bonnet it was found that the wing or swinging gate of the valve was worn and it dropped down far enough to allow it to "cock," that it was off its seat and in such a position as to allow a quantity of water to pass from the paper mill into the mains of the water company whenever the paper mill's pressure was greater than the water company's pressure, which occurred frequently, and the plaintiff claimed that it was in this manner that the water-supply became polluted. It was pointed out that all of the cases of typhoid, with but two or three exceptions, occurred in a section of the town embracing six or eight blocks adjacent to the American Strawboard Co.'s paper mill.

Mr. Walters' summary of the testimony did not disclose any denial by the company that the check valve leaked at the time of this test, but the water company introduced evidence to show that for a year previous it had tested the valve at least once a month and had always found it in proper working order.

Evidence was introduced (by which side is not stated in the summary sent by Mr. Walters) showing that Circleville is located on the Scioto River 30 mi. below the outfall of the Columbus sewage-treatment plant and "tending to show the presence of B. coli in large numbers in the water of the Scioto River at Columbus and also at Circleville," the latter in the vicinity of the strawboard mill in January, 1914. Evidence was also introduced that claimed to show that "for some time prior to the outbreak of typhoid the water in a portion of the mains of the water company was milky and evil smelling."

The defense of the company as summarized by Mr. Walters was as follows:

> The defendant denied that it had furnished impure water and denied that the plaintiff's intestate contracted typhoid fever by drinking water supplied by the defendant; denied that it had been negligent in any particular, and set up the defense of contributory negligence and contended that inasmuch as the citizens of Circleville had been cautioned and advised by the newspapers of the city almost daily to boil the water for safety, and the fact that it was notoriously well known and discussed by the citizens of the city that the public water might be polluted and might be the source for the numerous cases of typhoid, that the drinking of the unboiled water by the said Iva Grant, deceased, was such negligence upon her part as would preclude recovery by her administrator for her death.

The judge issued a long series of instructions to the jury which may be summed up as follows: The defendant company could not be held as a guarantor or insurer that the water furnished by it to its consumers did not contain pollution; the company could only be held "to exercise ordinary care in the operation of its plant," including a workmanlike installation of a standard check valve in the mill connection and ordinary care in testing the check valve; the company could not be held liable for an accident to the check valve. The judge declared further:

> Although you find that the defendant failed to exercise ordinary care in the operation of its plant, and that on account thereof said Iva Grant contracted typhoid fever from water supplied by the defendant and died as a result, I charge you that if you further find that Iva Grant had knowledge or reasonable means of knowledge that said water was polluted before and at the time she drank the same, then she took upon herself the risk of drinking such water and you must return a verdict in favor of the defendant.

The judge declared that "reasonable knowledge" that the water was polluted would be afforded by proof of warnings to that effect published in the newspapers and by open discussion of the alleged water pollution by neighbors and their caution to one another to boil the water.

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[1] The case was brought by Samuel C. Grant, administrator of the estate of Iva Grant, deceased, in a petition to the Court of Common Pleas of Pickaway County, Ohio, dated May 28, 1914. The decision was rendered by the jury on May 4 or 5, 1915.

The defense in the case was made by Barton Walters, of Circleville, Ohio, the attorney already mentioned, assisted by William Miller, an attorney of Columbus, Ohio, and by George A. Johnson, of New York City, and A. Elliott Kimberly, of Columbus, Ohio, sanitary engineers. The general supervision of the case was directed by A. W. Cuddeback, superintendent and engineer of the Passaic Water Co., of Paterson, N. J., in behalf of the Circleville Water-Supply Co.

Pier and Pile Foundations on Earth and Rock

Work on the Circle Building, a new and in some respects remarkable structure, is rapidly nearing completion. The building is located on an irregularly shaped plot on the north side of Columbus Circle, New York City. It fronts 261 ft. on Central Park West, 316 ft. on Broadway, 195 ft. on 61st St., and 38 ft. on the Circle end. The first floor of the building contains stores and display rooms, the second floor being devoted to office purposes. The original layout contemplated a five-story structure with a tower extending 25 stories above the roof. This plan is being held in abeyance and the building has been carried up only two stories. The idea of constructing a high tower, however, is still alive and the footings and columns in the central portion of the building were designed and constructed to take ultimately the load of such a tower.

Rock at the site varied considerably as to depth. Fortunately the low height of the building made it unnecessary to sink the piers to rock, except those designed to carry the proposed tower. These piers were in all cases sunk to rock by open excavation, rock being struck at a maximum depth of about 18 ft. At one point south of the center of the plot, along Broadway, rock showed about 6 in. below curb. The elevation of the grillage beams was 4 ft. below the cellar floor.

Where possible, the piers were excavated with bucket operated by A-frame bull-wheel derricks, but the smaller

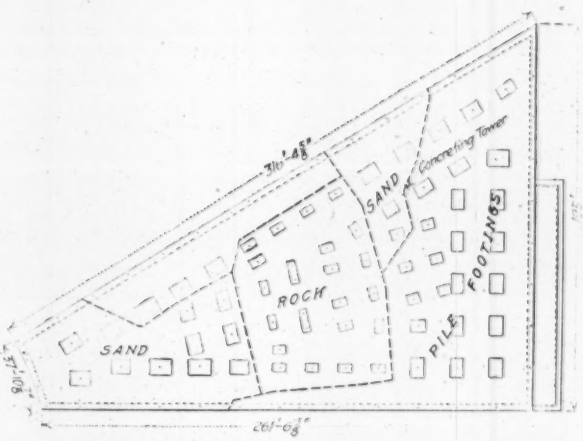

FIG. 2. FOUNDATION PLAN OF CIRCLE BUILDING.

piers had to be dug by hand. Those of medium size were dug out in stages (benched out). In the smallest holes pails were filled with earth and hoisted out by hand. The pier pits were sheetpiled with tongued-and-grooved yellow-pine piles 16 to 20 ft. in length. At the deep piers followers were used in driving the sheeting.

Fig. 2 is a foundation plan. The piers for the two-story part of the building rest on sand or on blue clay, and most of them have direct soil footings. At one corner several piers have Raymond concrete pile foundations. These consist of two to six piles per pier and a reinforced-concrete cap plate 3 ft. thick.

FIG. 1. GENERAL VIEW OF WORK ON CIRCLE BUILDING, SHOWING CHUTING SYSTEM IN OPERATION

FIG. 3. VIEW OF THE CIRCLE BUILDING SITE TAKEN TWO MONTHS AFTER FIG. 1
Grillage beams on piers in foreground. Recesses left in wall at right for later placing of columns

The cellar was excavated by a steam shovel, which started at one end of the site and worked in to the other end, where it turned around and dug its way out. The spoil was loaded on 3-ton motor trucks, which were loaded with 4 yd. Twenty trucks were employed, each hauling seven loads per day. The trucks were drawn out of the excavation by a cable operated by a hoisting engine.

Difficulties from Ground Water

A spring in the north end of the excavation caused very mucky soil in the vicinity. The water had to be pumped out of the pier excavation continuously. Double-diaphragm gasoline pumps were used in some cases, but these were only satisfactory on lifts of from 18 to 20 ft. For the most part high-pressure steam pumps were employed to jet out the water. Steam pressure as high as 110 lb. was used. Water from pier excavations was pumped into a receiving tank to allow the sand in suspension to settle. A pipe led from the tank to the sewer, though the sewers in the vicinity of Columbus Circle are very small for the duty they have to perform.

Puddled-Concrete Building Wall

A part of the building wall is carried on 238 concrete piles driven 2 to 2½ ft. c. to c., the spacing of the piles being less at column locations. The average penetration was 12 ft. It was necessary to proceed with the concreting before the steelwork was received. The grillage beams were secured and placed before the walls were poured, recesses being left in the walls at column locations to provide for the future placing of the wall columns. When the columns were received they were erected and forms placed in front of them and the recesses filled with concrete. Some of these recesses are visible at the right in Fig. 3.

The wheelbarrow method of distributing concrete from mixer to the required location was tried and quickly abandoned as being excessively costly. A 75-ft. tower[1] was then erected at the point indicated in Fig. 2 and the concrete chuted from a point 65 ft. above ground to all parts of the wall. The chuting run varied up to 200 ft. At the forms two men hoed the concrete, which was of soupy consistency, from the chutes into the forms and puddled the concrete thoroughly with scrapers similar to those used to remove ice from sidewalks.

An interesting point in connection with the excavation developed after the foundations had been built. It was determined that the boiler room was not as high as it should be. The column footings at this location were therefore underpinned and the floor of the boiler room was lowered 7 ft. by hand excavation. The soil was mucky,

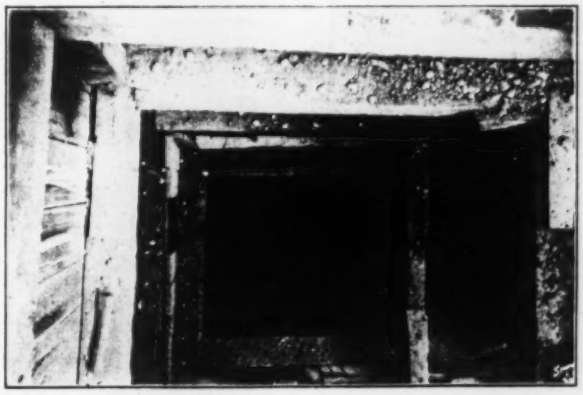

FIG. 4. TIMBERED DEEP-PIER EXCAVATIONS
Looking down into Nos. 57 and 58 of Fig. 1

so that it was necessary to keep gasoline pumps operating while work was in progress.

The general contractor is the Columbus Circle Construction Corporation, of which H. Mandel is president. The superintendent of construction for the contractor is F. L. Shea. R. E. Moss is engineer and James C. Green, architect. The building is owned by the Hearst interests.

[1] F. L. Shea, Superintendent of Construction for the Columbus Circle Construction Corporation, described the concreting plant used on this job in "Engineering News" of Sept. 2, 1915.

Development of Ultra-Violet Water Disinfection

SYNOPSIS—The adaptation of the ultra-violet water-treatment method to American conditions is outlined and some installations are described.

The gradual technical development of the use of ultra-violet light in sterilizing water has been variously noted in *Engineering News*[1]. During the past two years an American concern, the R. U. V. Co., of New York City, has been developing the ultra-violet process for American conditions. Some of the results secured are here given.

The theory of the ultra-violet process may be briefly summarized: Ultra-violet rays are given out in profusion by the electric arc between metal electrodes and especially by the mercury arc. But where glass walls inclose the arc stream, as in the case of the ordinary mercury lamp, the walls absorb a large part of the ultra-violet light. By putting the mercury arc in a quartz tube and working it at high intensity, the absorption is prevented and a possible source of intense radiations is provided.

The bactericidal effect of ultra-violet light is well known. The ordinary pathogenic organisms are easily and quickly disintegrated under its influence, but as the ultra-violet rays have no great penetrating power for opaque objects, it is advisable to remove the suspended matter from the water by filtration and then to run the water in thin streams past the source of light. To guard against the effect of microscopic suspended matter, a single passage of the water is not relied on, baffles and tortuous passages being arranged to give several exposures of a given quantity of water, which has been thoroughly stirred up.

[1]The sterilization of water by ultra-violet rays was noted in the following articles: "Sterilization of Polluted Water by Ultra-Violet Rays," Sept. 15, 1910; "Sterilization of Polluted Water by Ultra-Violet Rays at Marseilles, France," Dec. 8, 1910, and Dec. 7, 1911; "Water Purification by Ozone, Ultra-Violet Rays, and Chlorine," Aug. 24, 1911, Oct. 17 and Dec. 19, 1912; "The Application of Ultra-Violet Rays for Purifying Large Quantities of Water," Aug. 21, 1913.

Early Work and American Conditions

The early work was done with water not under pressure or in a closed system. The most of the potable American water-supplies that might be treated by ultra-violet rays, where electricity can be supplied and good supervision secured, require that the process be carried on while the water is passing through a pressure system. Therefore only the principles of the process as worked out abroad are of particular service in this country; quite new apparatus has had to be developed. The cases where the water being treated flows in open channels are the small supplies in which the water is drawn off slowly into storage bottles, etc., or circulating systems for swimming pools.

Of some 320 plants installed or approaching completion in this country, 20 are for swimming pools, about 200 are of the small gravity-flow units of 60 to 120 gal. per hr. capacity, and about 100 are of the larger pressure-type sterilizers of 200 to 3000 gal. capacity. The first cost is about $750 per 1,000 gal. per hr. capacity for the larger machines, rising to about $900 for the smallest.

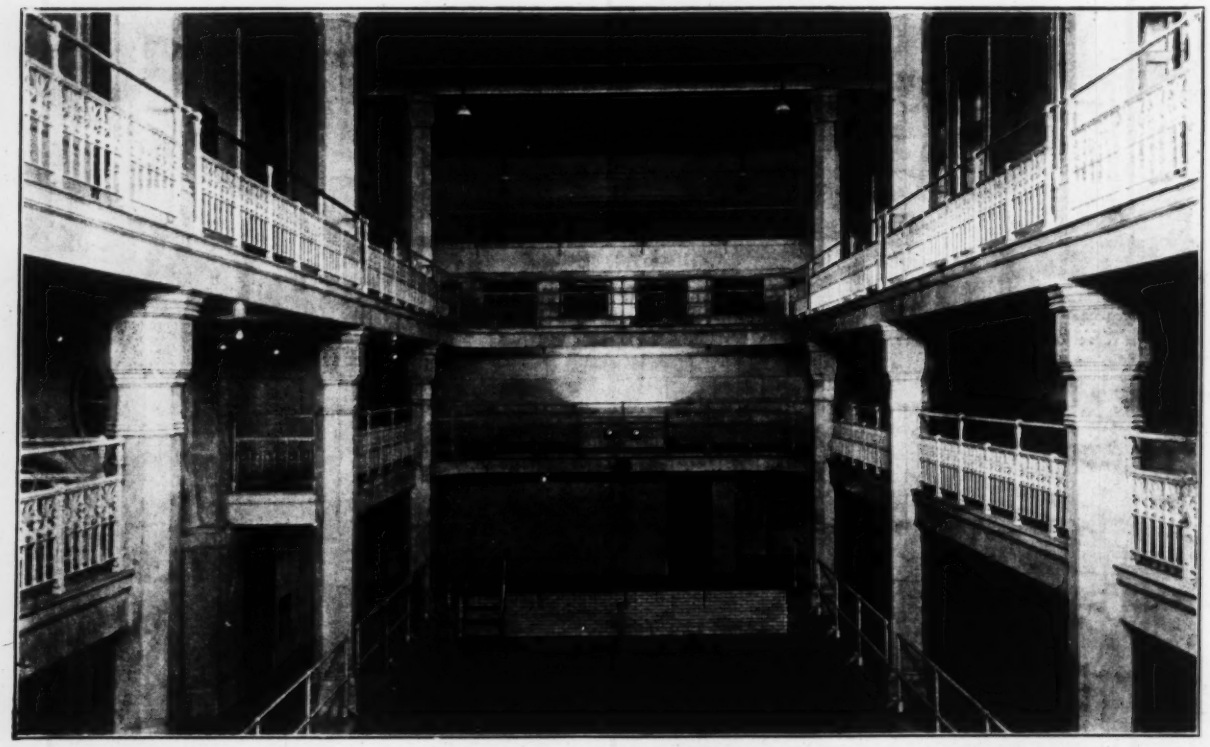

FIG. 1. SWIMMING POOL AND ULTRA-VIOLET RAY STERILIZER, NEW YORK ATHLETIC CLUB

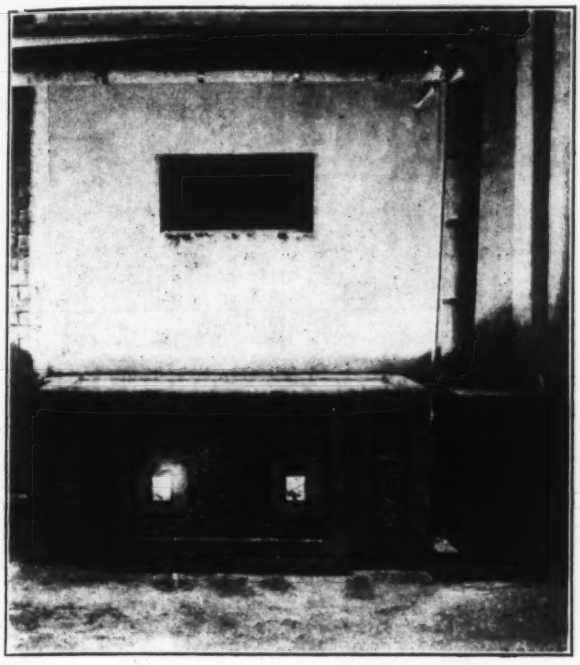

FIG. 2. STERILIZING TANK AT WEST SIDE Y. M. C. A., NEW YORK CITY

Direct current is required for the lamps in all cases. For the smallest machines the supply is at 110 volts, for the larger ones it is at 220 volts, while the largest require 500. Where direct-current at proper voltage is not available, rectifiers or motor-generator sets are used.

Disinfection Tanks for Swimming Pools

When ultra-violet light is used in purifying the contents of swimming tanks, the water is circulated, filtered and sterilized. It is led off, as usual, by the drain at the lowest point of the swimming tank, and forced by a small motor-driven centrifugal pump through filters to the sterilizer tank, which is usually elevated so that the water may run through and discharge by gravity. Fig. 1 shows such an installation at the New York Athletic Club and Fig. 2 that at the West Side Y. M. C. A. in New York City.[2] In each of these places two mercury-arc lamps are used, the sterilizing tanks being provided with baffles so that the water passes repeatedly under the rays.

Tests of the water at the New York Athletic Club showed a count of 280 bacteria per c.c. (agar plates at 40° C. for 24 hr.) in a sample taken over the drain pipe, with B. coli present in 75% of the 1-c.c. inoculations. The count at tank outlet was 2 per c.c., with no B. coli in 10-c.c. inoculations. At the West Side Y. M. C. A. the count before installation of the ultra-violet sterilizer was 2,200 to 5,100 per c.c., with B. coli present. This quickly dropped to 400 to 600, with no B. coli; and eventually ran from 10 to 70 in the pool, with no B. coli found.

Further development of the swimming-pool sterilizer is being made to evolve a standardized line that can be installed without the special work now often involved.

[2]Besides the two swimming-pool installations shown in Figs. 1 and 2, notable examples of these sterilizers are to be found at such places as the West Side Y. W. C. A. in New York, the Germantown Y. W. C. A., the Detroit and Dayton Y. M. C. A. buildings, the Minneapolis Athletic Club, the Forest Home School in Milwaukee, and the Forest Park Highlands, St. Louis, Mo., the last for a large open-air pool.

The design of sterilizer shown in Figs. 3, 4 and 5 has been developed for treating water under pressure. The water flows in a circuitous path through an iron casing in the center of which is packed a quartz tube whose interior is open to the air for the insertion of the mercury-arc lamp. The flow is divided, and on each side the baffles are arranged so that the water passes back and forth radially, coming close to the lamp twice. These types are made in two sizes—one for 600 to 1,000 gal. per hr. and the other for 1,000 to 3,000 gal. The smaller one requires 0.55 kw. power and the larger 1.25 kw. The lamps used are shown in Fig. 5. The only labor required is the tilting of these lamps to start and an occasional cleaning of the casing.

Where the water to be treated is not perfectly clear, the supply has to be prefiltered, the type usually employed being a vertical pressure cylinder packed with sand, charcoal or bone black—depending on the quality of the raw water. The loss of head through the filters is from 6 to 12 ft., while that through the sterilizer is 2½ ft. for one size and 3 ft. for the other. Where the pressure head of the supply system is not large enough to pass the water through the sterilizers and deliver properly, booster pumps are employed. Where it is desired to treat supplies greater than the capacity of a single unit, two or more are used in parallel; it is not unusual to install a duplicate sterilizer as a spare unit for use in contingencies.

Automatic lamp control for large sterilizers and full electric control of water flow are being developed. When these are perfected the entire sterilization process can be controlled from the switchboard.

Out of the earlier design of small gravity-flow sterilizer first furnished, the automatic type shown in Fig. 7 has been developed. Water flows into an enameled iron tank

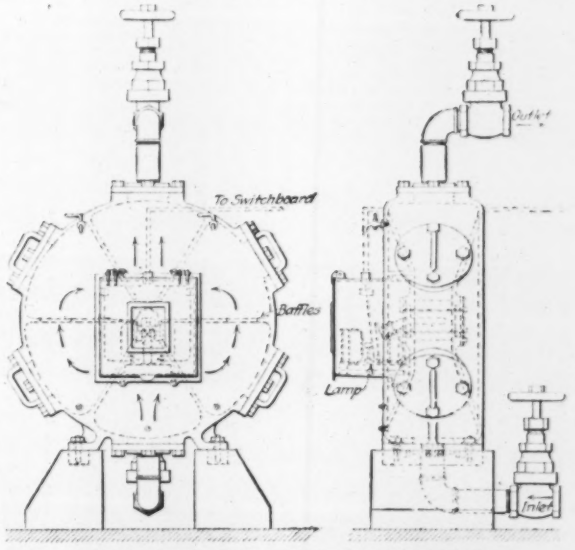

FIG. 3. PRESSURE TYPE OF STERILIZER

and around baffles so that it passes twice in thin streams close under the lamp. The lamp frame is fastened to the plunger of a solenoid through which the main current flows; closing the lamp circuit then lifts the lamp and starts the arc, while breaking the current causes the mercury tube to lower ready for starting again. Where the total daily consumption is small but there are occa-

sional heavy drafts of water, this sterilizer has been used, overflowing into a storage tank.

A small pressure sterilizer (200 gal. per hr.) has been built along the lines of the apparatus shown in Figs. 3, 4 and 5. A different type of lamp is used, however, such that automatic tipping of the lamp, as previously noted, is obtained.

Many Carbon-Free Metals and Alloys Now Available

In many metallurgical operations there is need of employing carbon-free metals and alloys in order to control fully the physical properties of the final metal, which may be a special steel or bronze, for instance. A large number of these have been developed by the Goldschmidt Thermit Co., of New York City, employing in their production the well-known aluminum-oxidation reactions by which a high temperature is produced in carbon-free surroundings. A brief review of the uses of most of these is given, from notes by H. De Courcy Browne, metallurgical engineer of the Thermit Co., in the paragraphs which follow. The approximate analyses are appended in a group.

Pure Manganese Products

Manganese, 97-98% pure, has been a commercial product for over 10 years. Its melting point is about 1260° C. It dissolves very readily and alloys can be easily made with chromium, aluminum, copper, zinc, tin, nickel, titanium, etc. It is not detrimental to some work where the usual 80% ferro-manganese with its combination of iron and carbon has been dropped. It is used in the manufacture of cupro-nickel, german-silver and aluminum sheets, where it has been found that a small addition increases the ductility in rolling. It is also used in the manufacture of manganese bronze and is especially advantageous where a high manganese and a low carbon content is desired. Manganese is generally added in the ratio of about ¼ to ½%, although in some resistance metals the content goes as high as 10%. This metal in powdered form is used by steel foundries to obtain a hardened surface on certain parts of steel castings; the "flour" is mixed with a binding material and swabbed on the mold where it is desired to harden the casting.

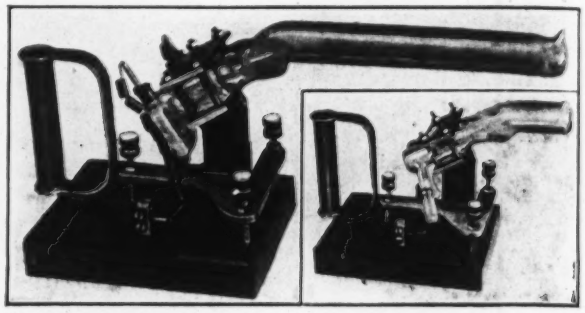

FIG. 5. PISTOL-TYPE MERCURY-ARC LAMPS

Chromium, Cobalt, Copper and Nickel

Pure chromium (98 to 99%) is generally used in resistance metals and mixtures where a high chromium content is desired; for example, in fine tool steels, projectiles, etc. The general addition of pure chromium is about ½ to 4%. In resistance metals the content often goes to 15% and even 30%.

Cobalt, made in 97% purity, has aroused great interest in the steel business since 1913. It is used in ordinary high-speed tool steel, where it is believed that the addition of about 5% improves the cutting qualities. The possible use of cobalt in brasses and bronzes is being studied.

Cobalt-copper: A small addition of cobalt, from 0.10 to 0.25%, increases the physical strength of brass and bronze castings and drawn wire, and of manganese-bronze, low brass and "88-10-2" or gun metal. In this nonferrous work, a 10% cobalt-copper alloy can be used to advantage.

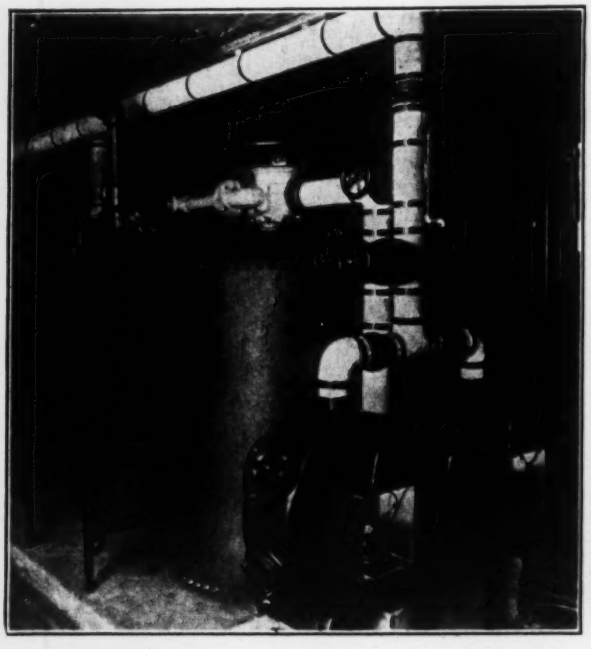

FIG. 4. STERILIZER INSTALLATIONS AT MARSHALL FIELD STORE, CHICAGO

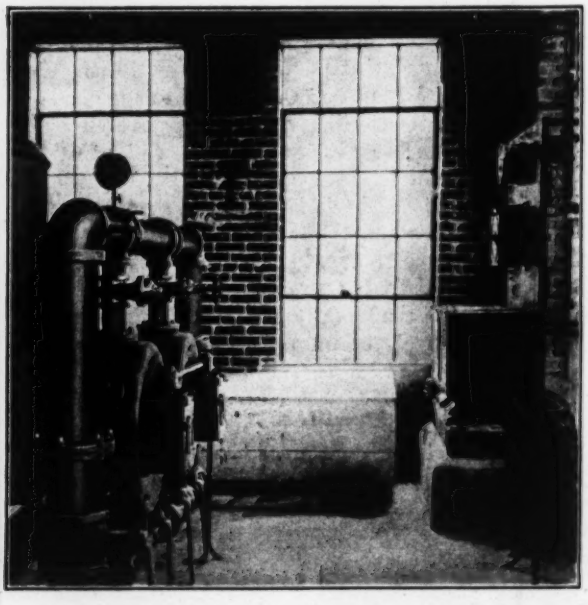

FIG. 6. INSTALLATION OF VALLEY PARK (MO.) WATER CO.

A 50-50 nickel-copper alloy is one of the new combinations. It is used in german-silver castings and where a small percentage of nickel is desired in bronzes of high physical strength. This alloy dissolves at a much lower temperature than pure nickel so that it is not necessary to raise the temperature of the treated metal above normal. Nickel is also thus introduced in a plastic lead or bearing alloy to prevent segregation of the lead. In all so-called red-metal alloys where nickel

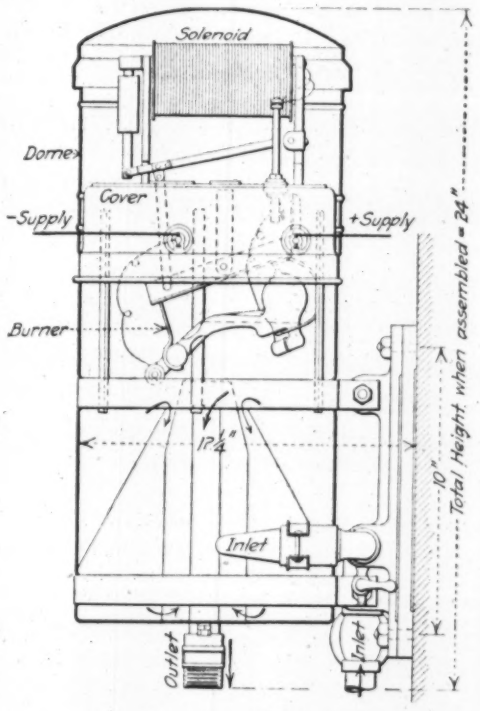

FIG. 7. ARRANGEMENT OF SMALL AUTOMATIC ULTRA-VIOLET STERILIZER

is introduced to promote fineness of grain and increase of tensile strength this combination is economical.

Carbon-Free Ferro-Alloys

Ferro-titanium, 25%, is used with both iron and steel; a small addition, generally about 1¼ lb. of the alloy per ton of metal treated, tends to cleanse the metal thoroughly, the titanium having an affinity for oxygen and nitrogen. With carbon-free alloy no carbides are formed and all the titanium is available to the steel or iron, resulting in an exceptionally dense and close-grained metal.

Ferro-chromium, 60%, has a very wide commercial use and many steel makers prefer it to the low-carbon electric-furnace product. The general addition of ferro-chromium would be about the same as for pure chromium.

Ferro-vanadium, either 25 or 40%, is used in practically all grades of tool steel, where it has been found that vanadium has a tendency to intensify the hardening and toughening effects of other alloys. Vanadium is also used in steel castings that are subjected to high static and dynamic loads. Probably in from 50 to 75% of the locomotive frames the metal is treated with about ¼% of vanadium. In locomotive cylinders it has been found that vanadium will close the grain of the iron and produce better castings. In steels for automobile parts, such as gears, axles, crankshafts, etc., this alloy is widely employed. The usual addition of vanadium is about 1%. For high-speed and crucible tool steels, for automobile steel and steel castings it is generally about ¼%. With cast iron the addition is usually about $\frac{1}{10}$%.

Ferro-boron, so far, has had only a very narrow commercial field, although lately considerable study has been given to the use of boron in various steels in the hope of ascertaining the field for this element.

Ferro-chrome-cobalt is used in chromium-cobalt steels and some melters prefer it to using cobalt and chromium metals separately. The addition of this alloy is the same as cobalt.

Carbon-Free Manganese Alloys

Manganese-titanium is generally used in high-class bronzes, where it has the advantage of the strong combination of manganese and titanium. It is a very stringent deoxidizer and will also increase the physical strength considerably. The addition of alloy is generally about ¼ to ¾%.

Manganese-boron is used for the same general work as the manganese-titanium alloy just mentioned, although boron is used considerably for high-conductivity copper castings. It is used under the same general conditions and in the same ratio approximately as manganese-titanium.

Chromium-manganese is advantageous for certain classes of work where otherwise chromium would have to be used separately. It dissolves at a considerably lower temperature.

Manganese-aluminum, 25 to 75%, is a new development. This is made from the 98% pure manganese and is technically free from iron and carbon, both of which are extremely detrimental in aluminum work. This alloy dissolves at a low temperature, and its usual effect on aluminum castings is to reduce shrinkage, close the grain and increase density. Considerable improvement in strength, without appreciable loss in ductility, can be obtained.

ANALYSES OF CARBON-FREE METALS AND ALLOYS (EXPRESSED IN PER CENTS)

	Pure Manganese	Cobalt-Copper	Pure Cobalt	Pure Chromium	Chromium-Manganese	Manganese-Boron	Manganese-Titanium	Ferro-Chrome Cobalt	Ferro-Boron	Ferro-Vanadium	Ferro-Chromium	Ferro-Titanium
Manganese	97.–98.	Trace			70	60.0–62.0	54.0–55.0				0.25–0.50	0.25–0.50
Aluminum	0.25–0.50	0.10–0.25	0.25–0.50	0.25–0.50	0.10–0.25	1.0–1.5	5.0–6.0	0.25–0.50	1.00–1.50	0.25–0.75	0.50–	1.0 or 6.0
Silicon	0.50–0.75	Trace	0.25–0.50	0.10–0.25	0.25–0.50	0.5–1.0	3.0–4.0	0.50–0.75	0.25–0.50	0.25–0.75	0.50–0.75	0.50–0.75
Iron	0.50–1.00	Trace	1.00–2.00	0.25–0.50	0.25–0.50	0.5–1.0	1.0–1.5	20.0	Balance 75.0–78.0	Balance 75.0 or 60.0	Balance 40.0	Balance 70.0
Phosphorus	0.10–0.25	Trace	Trace	Trace	Trace					Trace	Trace	Trace
Sulphur	Trace	Trace	Trace	Trace	Trace					Trace	Trace	Trace
Cobalt		10.0	97.0					40.0				
Copper		89.0										
Chromium				98.0–99.0	30.0			40.0			60.0–61.0	
Boron						35.0			20.0–25.0			25.0
Titanium							35.0					
Vanadium										25.0 or 40.0		
Arsenic			None									
Nickel		1.00										

City Planning in Queens Borough, New York--I

By Frank B. Tucker*

SYNOPSIS—A description of the methods employed in converting the largest and most rural of New York City's five boroughs into a real city: showing how a comprehensive city plan is being worked out so far as possible within legal limitations and complications.

The Borough of Queens, New York City, with an area of 117.1 sq.mi., is the largest of the city's five boroughs. It is part of Long Island and extends from the East River and Long Island Sound on the west and north to the Atlantic Ocean on the south.

Previous to its inclusion within the corporate limits of the City of New York (1898) the Borough of Queens, then a part of the County of Queens, comprehended Long Island City, the towns of Flushing, Jamaica and Newtown and part of Hempstead; eight incorporated villages—College Point, Flushing, Whitestone, Jamaica, Richmond Hill, Rockaway Beach, Arverne and Far Rockaway; and numerous unincorporated communities.

At the time of the consolidation, only one existing map, that of Long Island City, containing 4741 acres, was officially accepted; of the remaining 70,370 acres, there were no official surveys or maps. The work of making these surveys was begun under the old Board of Public Improvements of the city, in accordance with the general plan of making complete topographic surveys of all the boroughs.

Until 1903 the topographic survey work in Queens was almost wholly of a preliminary character. The triangulation on which the survey of the Borough of the Bronx is based was extended to Queens, and numerous triangulation and traverse stations were established there. A net of levels was also run, establishing benchmarks. The work of these years proved of inestimable value when the work was taken up in Queens as a problem separate and distinct from the other boroughs, following the abolishment of the Board of Public Improvements (1902), when topographical survey bureaus were established in all the boroughs.

Work of the Topographical Bureau

Following the establishment of the Queens Topographical Bureau, a comprehensive line of work was determined upon: (1) A topographic survey; (2) a tentative street system design based upon the topographic survey; (3) a detail property survey of existing streets and their demarkation upon the ground with monuments as well as the demarkation of new streets; (4) a final map laying down the lines of all streets, their widths and grades, and the linear and angular dimensions of all blocks as determined by the detail property survey and by computations.

The Bronx triangulation system has for its axes of coördinates, Tenth Ave., Borough of Manhattan, and 225th St., Borough of the Bronx. The Tenth Ave. axis is 28° 59′ 13.5″ east of true north; the 225th St. axis is, of course, normal to this. These axes were retained by the Topographical Bureau, and to them all its coördinates still refer. Eventually, however, they will be transformed to the triangulation system of Greater New York, established for the city in 1908 by an officer of the United States Coast and Geodetic Survey (see *Engineering News*, May 21, 1903, page 456).

Topographic Survey Methods

The nucleus of control for the topographic survey was the traverse and level net that the old Board of Public Improvements had spread over the borough. Most of the traversing was done with 50- and 100-ft. tape catenaries, provided with handles for adjustment to tension and temperature. At frequent intervals the tapes in service were compared with one standardized at Washington. All measurements were made twice and required to check within 0.02 ft. in 1000 ft. Angles were turned 24 times (angle 12, explement 12, each 6 times with the telescope erect and 6 times with the telescope inverted). The closures were within $\frac{1}{2}'$ sec.

Levels were run with common wye levels and ordinary target rods, reading to 0.001 ft., with foresights and backsights equalized, 225 ft. being taken as the criterion for a proper sight. Two rods were used and each was read separately on every turning point and benchmark. The operation was then repeated with a new setup of the level in approximately the same position. The mean of all the readings was taken as final, and in a given run the allowable error was $0.02\sqrt{\text{distance in miles}}$.

Nearly all topography was taken with planetables. This work is now complete, but at its height seven planetable parties were in the field, composed of six men each. All planetable work is to a scale of 1 in. = 80 ft.; each sheet covering a strip of country 2,000 ft. wide, and of variable lengths, depending on conditions. On each sheet were first drawn the range and traverse lines in blue and green respectively; the range lines were 500 ft. apart.

In the fieldwork there were few departures from conventional methods. The purpose of this survey was to gather data necessary for the design of a street system, so accuracy and speed were the prime requisites. Accuracy in the determination of existing street lines was of paramount importance; next, buildings and contours. The latter were of 5-ft. intervals, and were run out in the field. To do this a level was used in conjunction with the planetable and two or sometimes three rodmen were employed.

As soon as a planetable sheet was completed, it was turned into the office, where it was transferred *in toto* to mounted sheets, 31x53 in., representing an area of 2,000x4,000 ft., or 183.6 acres. For many purposes a scale of 80 ft. to the inch is too great, so these sheets were pantographed down to a scale of 1 in. = 200 ft., on mounted sheets of the same size as for the other scale.

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These sheets then included an area of 5000x10,000 ft., or 1148 acres.

Tracings are made of these 200-ft. topographic sheets and prints taken; these are matched and pasted together until they comprehend a large area. This assembled print serves as a study plat, wherewith to work out the design of a street and grade system.

Design of the Borough Street System

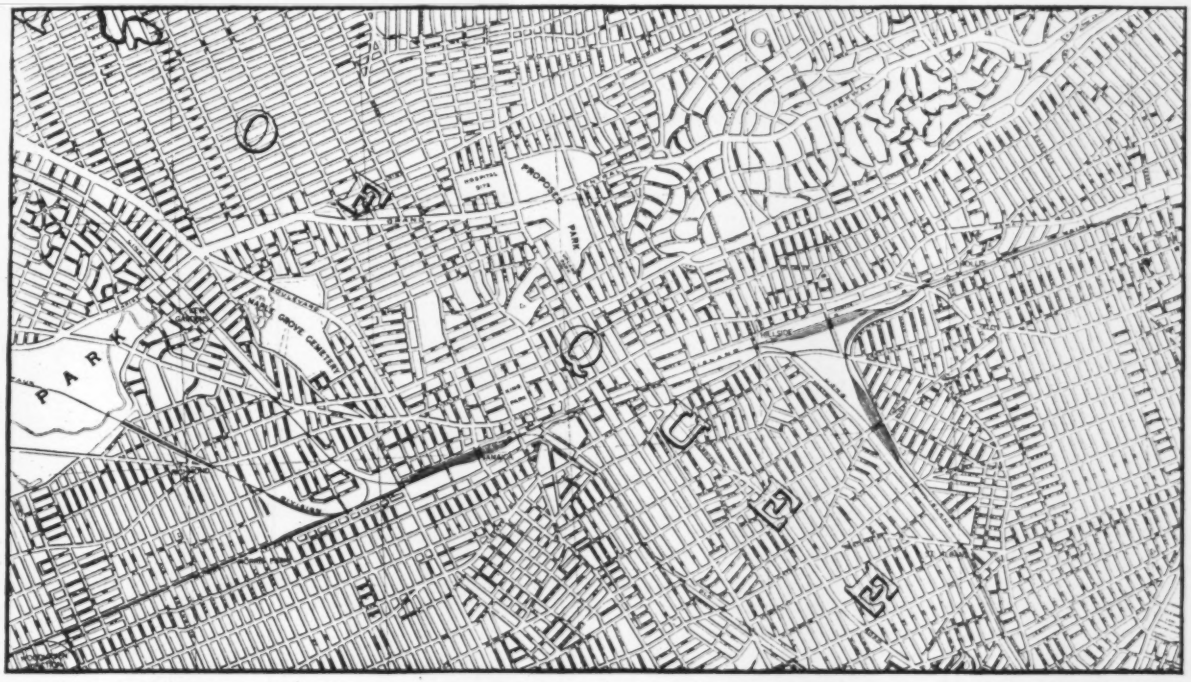
In designing the street system of Queens, the engineers of the Topographical Bureau have recognized from the first that a great influx of population would follow adequate transit connections with Manhattan and Brooklyn, and have attempted to design a street system that would weld together the multitudinous existing streets into a comprehensive and harmonious whole, in anticipation of such development. Queens has offered little leeway to apply idealistic principles of city planning.

On the assembled prints of the reduced planetable sheets careful study of the undeveloped areas is made to determine their proper street treatment, and of the developed areas to determine the streets that shall be widened and those that shall be discontinued.

For the undeveloped areas blocks 200x600 ft. are freely used, with the long dimension parallel to the trend of probable greatest traffic. This size of block gives 48 lots, 25x100 ft., or 60 lots, 20x100 ft., the lot dimensions common in New York. When conditions require blocks of other dimensions or of irregular shape, the aim is to obtain the greatest possible number of lots 100 ft. deep, for this depth of lot seems peculiarly adapted to New York's needs—a greater depth not appreciably increasing values, but a lesser depth materially decreasing them.

New York seems to have adapted itself to streets 60 ft. wide and avenues 100 ft. wide. These were the widths used when the street plan of old New York City was laid out in the first decade of the Nineteenth Century, and to these widths, especially the former, both public and private streets have been opened, although in a number of instances parsimonious real estate promoters used a lesser width.

In designing the street system for the Borough of Queens, 60 ft. and 100 ft. have been the widths commonly used, although intermediates have been freely admitted. Two marked exceptions, involving the use of greater widths, deserve special attention: Queen's Boulevard, extending from the Queensboro Bridge to Jamaica, a distance of nearly six miles, is to be the widest street in the Borough—200 ft. The city has already acquired title to the right-of-way; its physical treatment, however, due to its exceptional width, is as yet only partially determined. If present plans mature, Grand Central Parkway, 150 ft. wide, will extend from Queen's Boulevard near its Jamaica terminus, eastward (atop the "backbone" of Long Island, affording in places a view of both Long Island Sound and the Atlantic Ocean) to the boundary of the City of New York, a distance of about 7½ miles.



SECTION OF MAP OF QUEENS BOROUGH, SHOWING HOW EXISTING AND NEW STREETS ARE HARMONIZED

Adjusting Street Grades to Topography

The fixing of street grades has not been difficult from a topographic viewpoint. The topography of Queens is not rugged, and in only a few sections is it necessary to observe contours in locating streets. With new streets, drainage and a minimum of earthwork are the governing considerations.

With existing streets, difficulties are frequent, because of the economic necessity of recognizing improvements already installed. It is, of course, impossible always to hold present grades, but in most cases a careful study will reveal means whereby it may be done or at least close-

ly approximated. Crowns within the block will often accomplish the desired purpose.

In fixing grades those at curb and house lines should be officially established as well as those at center line; otherwise discrepancies will occur at these points by reason of surveyors using different methods of interpreting the center-line grades.

At the time of designing the street system, areas whose natural topography suggest their adaptability to park purposes are set aside. But the city's present policy of assessing the cost of its park purchases upon the limited area especially benefited is not propitious to the early acquisition of these lands for parks. There is nothing to prevent the owners of these areas proposed as parks by the Topographical Bureau from subdividing them into building lots or otherwise disposing of them; thereby augmenting their cost and the difficulty of their purchase when congestion of population will have made their acquisition still more desirable.

Widening the Existing Streets

The design of a practicable street system requires the widening of many existing streets and the discontinuance of others. The experience of the Topographical Bureau with such streets has not been very satisfactory. On the first designs prepared, the number of widened and discontinued streets shown was plentiful, but the accomplishment of these improvements was defeated in most cases by the property owners or by legal difficulties. The result was that for several sections the street design had to be entirely recast to incorporate some old road, or to hold existing streets to their present width.

The cost of widening a street in New York City is now a matter of local assessment; consequently property owners are bitterly opposed to all street widenings, although tacitly admitting the wisdom of such procedure. They view wide streets as a benefit to the whole community and clamor to have a large portion of the cost placed upon the city at large (a practice that obtained in past instances) or the scheme abandoned, a prerogative that a majority of those affected can exercise.

An arbitrary rule of the City Board of Estimate and Apportionment is that streets of a length greater than 1500 ft. shall be at least 60 ft. wide. This rule cannot be rigorously applied. Many streets of a lesser width, usually 50 ft., are of purely local importance and can never become important traffic streets. The widening of such streets is always protested by property owners.

In other cases, streets of lesser width have been extensively improved with buildings, and damage claims, were the streets widened, would be prohibitive; and as there is no law in New York making it obligatory for new buildings to observe widened lines, these streets must be continued at their present width.

The determination of what streets shall be widened, and whether the widening shall be on both sides or only one, are matters that require a thorough investigation in each instance. Where no buildings are affected it is usually best to divide the widening equally between both sides, otherwise the lots on the widened side may be so materially shortened as to seriously impair their value. Where buildings have to be moved or removed economy will generally require that the widening be all on one side, except in the widening and straightening of old roads, where, by shifting from side to side, it is often possible to avoid buildings.

Discontinuing Existing Streets

The discontinuance of an existing street is difficult. The statute law relating to the discontinuance of streets in New York City is most comprehensive in phraseology, but is applicable to only a few streets. In brief it vests in the proper local authorities full power to discontinue all streets necessary effectually to secure and preserve regularity and uniformity in a general and permanent street system. It states that upon the filing of an official map establishing a permanent street system for a section the streets shown thereon are the only lawful streets, and that the fee owner of a street not shown thereon may inclose, use and occupy the area as fully as if it had never been a street, if not then in use, or if in use, upon the day a permanent street is physically opened to take its place.

Seen from an engineer's viewpoint the leeway allowed by this law for the discontinuance of a street at variance with a proper street plan is all that could be desired; but from a legal viewpoint it is beset with many difficulties. Its weakness lies in its failure to provide a practicable disposition of the street upon its discontinuance. And what is true of this law is true probably of any law that can be evolved for the case.

Who Is the Fee Owner of a Street?

It is all very well to say that the fee owner may inclose, use and occupy the area as if it had never been a street; but who is the fee owner?

The reversion of a street upon its discontinuance to the fee owner thereof as provided by this law is possible and equitable only when the fee-ownership of the abutting property upon both sides is in the same person, or in persons in full sympathy and accord with one another, which is seldom the case.

To determine the fee ownership of a street is often impossible because the fee is lost either in the incompleteness or in the total absence of an official chronicle of its succession from the patents of Holland and England. To the streets that date from the Dutch occupation of New Amsterdam (New York) the fee title is acknowledged to be in the city. But to the streets that date to the sovereignty of England, the city claims only an easement title. In the case of streets that date from American Independence no generality is possible, fee or easement titles being acquired according to the idiosyncracy of each community or to individual whim if privately opened and tendered to the authorities.

Establishing Identity of Streets

To discontinue any street other than one whose fee is in the abutting owner is quite impossible—in the case of the old Dutch streets, because of the absence of all data conclusively establishing their identity and defining them by bearings, distances and widths; with the English streets there is the same absence of dimensions. Their identity, however, is possible as there is extant an excellent map of New York and Staten Island and a portion of Long Island, made in 1781 by General Sir Henry Clinton, Commander-in-Chief of His Majesty's Forces, then occupying New York. By eliminating from this map the few streets of possible Dutch origin, we have left those opened during the English colonial days.

From the close of the Revolution to about the end of the first half of the Nineteenth Century, street records are very meager and unsatisfactory. With the exception of the regularly incorporated turnpikes, proof of streets originating during this period is arrived at more by a process of elimination than by recorded evidence, land being of too small value to warrant any elaborate street opening procedure.

Beginning with about the latter half of the Nineteenth Century, land values began to rise rapidly, and where streets were opened by the authorities, the statutory legal requirements were observed. Consequently surveys and descriptions of a more or less satisfactory nature are matters of record for these streets, where the records have not been lost. Besides the streets regularly opened by the authorities, most of those privately opened by real-estate promoters, through the subdivision of acreage into building lots, also date from this period. The filed plots of these subdivisions in the county clerk's office are very complete, and the dimensions they give are dependable.

The discontinuance of any of these streets would of course work hardship to the abutting owners, though in the case of streets originally private there is no implied obligation on the part of the authorities as to their permanency; but there is on the part of the persons who privately opened them. While the city may officially discontinue a street, its fee owner cannot take physical possession of it, because he has parted with an easement in it to every person to whom he has sold property fronting upon it.

Some Guiding Principles

It must always be borne in mind that the cost of any change in the grade, width or alignment of an existing street will be a tax upon the community, usually levied directly upon property owners in the immediate vicinity; perhaps very poor people struggling to own a home and already heavily burdened with mortgages and general taxes. Unless of obvious necessity or palpable advantage the width and grades of existing streets should be held, for against the opposition of affected property owners the accomplishment of changes is impossible.

The exception to this statement is the old arterial highways. Their continuance as urban streets at their existing widths and grades is quite out of the question, and their discontinuance is precluded by the almost certain confusion of their fee title; so they must be developed and utilized to the best advantage. This will usually be found to be their continuance as arterial thoroughfares, for as originally laid out, they probably represent the line of least resistance between the several communities which they serve.

The experience of the Topographical Bureau has shown that the best mode of treating these old highways is to widen them, improving their alignment and grades, and use them as axes from which to extend rectangular street systems. In their widening, however, care must be taken to include the lines of the old highway entirely within those of the new, for otherwise there will be left a strip of the old street between the new and the abutting private property, the fee title to which may be impossible of adjudication.

A second article will describe the engineering work done in establishing the predetermined city plan, of which the accompanying illustration is typical.

Costs of 12- and 16-Ft. Lengths of Cast-Iron Pipe Laid

By F. C. Roberts*

When the manufacture of 16-ft. lengths of cast-iron pipe was undertaken by the American Cast Iron Pipe Co., of Birmingham, Ala., a year or more ago, it was apparently regarded by other manufacturers of this commodity as a more or less hazardous business innovation, and by users of cast-iron pipe as somewhat of an experiment. Both classes seem to have been unaware of the fact that the manufacture of 16-ft. lengths of cast-iron pipe has long since been successfully practiced on the Continent of Europe.

In the hope of stimulating argument on a subject that is of importance to users of cast-iron pipe, I subjoin the following cost figures, of laying both 12- and 16-ft. lengths of pipe. The figures given are complete as to all details of the work, except overhead charges (interest, depreciation of tools, superintendence, etc.). It should be remembered that all costs fluctate with the wages and efficiency of skilled and unskilled labor, the character of the work demanded, and other local conditions.

The wage scale was $4 for skilled labor, $3 for unskilled, and $5.50 for teams, all working 8 hr. per day. Lead cost $0.0445 and hemp cost $0.05 per lb. The trenches were 20 in. wide and had depths of 28 in. for the 4-in., and 30 in. for the 6-in. pipe, and bell holes at intervals of 12 and 16 ft., according to which length of pipe was being used. The soil was a sandy loam. Shoring was not required, and there was no macadam or pavement. The backfilling was done with a scraper and the water tamping and crowning by hand labor.

Table 1 gives general comparative data for the pipe alone, and Table 2 gives field costs for the pipe in place. The figures are for unbroken runs of pipe; that is, specials, hydrants and valves have been omitted, since these vary with almost every job.

TABLE 1. GENERAL DATA FOR 4- AND 6-IN. CAST-IRON PIPE IN 12- AND 16-FT. LENGTHS

Diam., in.	Length, ft.	Approx. Weight per Length, Lb.	Total Lengths, Ft.	Total Weight, Tons	Cost of Pipe, F.o.b. At Shop	Cost of Pipe, F.o.b. At Destination
4	12	260	40,000	434.0	$20.40	$33.40
4	16	340	40,000	425.0	21.40	34.40
6	12	400	4,000	66.6	18.40	31.40
6	16	520	4,000	65.0	19.40	32.40

TABLE 2. FIELD COSTS PER FOOT OF LAID PIPE

	4 in. x 12 ft.	4 in. x 16 ft.	6 in. x 12 ft.	6 in. x 16 ft.
F.o.b. destination..	$0.3623	$0.3655	$0.5228	$0.5265
Distribution	.0054	.0053	.0083	.0081
Trenching	.0576	.0576	.0600	.0600
Laying and cutting	.0120	.0112	.0184	.0171
Yarn and lead....	.0316	.0237	.0431	.0324
Fuel	.0033	.0024	.0046	.0035
Yarning and leading	.0045	.0037	.0067	.0050
Bell holes.....	.0166	.0125	.0208	.0156
Calking*	.0062	.0046	.0091	.0070
Testing†	.0051	.0048	.0059	.0054
Backfilling‡	.0216	.0215	.0225	.0223
Totals	$0.5262	$0.5128	$0.7222	$0.7029

*All calking was done by hand. †Testing includes touching up or repouring defective joints. ‡Backfilling includes tamping.

COMPARATIVE SUMMARY OF COSTS

Diam., In.	Total Length, Ft.	Pipe Length, Ft.	Cost per Ft.	Total Cost
4	40,000	12	$0.5261	$21,048
4	40,000	16	.5128	20,512
Difference			$0.0133	$536
6	4,000	12	$0.7222	$2,888
6	4,000	16	.7029	2,811
Difference			$0.0193	$77

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Kansas City Maintains Open Asphalt Specifications

By Clark R. Mandigo*

SYNOPSIS—With the experience gained in building and maintaining 4,000,000 sq.yd. of asphalt pavement, the engineers of Kansas City, Mo., have developed specifications and tests for asphaltic cement which are simple and easily understood, and which are truly open specifications, in that they pass all asphaltic cements which service shows makes satisfactory pavements.

Within the past ten years a large number of asphaltic cements, including various natural bitumens, the blown oils and manufactured asphalts have been placed on the market. Municipal engineers have been confronted with the problem of selecting the good and discarding the bad. When the almost infinite variety of mixtures, fluxes and degrees of refinement are considered, the difficulty of making a proper selection is apparent.

Within recent years considerable progress has been made toward standardizing asphalt tests, but although the majority of cities use a so-called "open" specification, there is little agreement except on a few of the older tests. This condition is caused largely by those who sell asphalt. Unlike cement and brick manufacturers, who have been untiring in their efforts to standardize tests for their materials, the asphalt interests have been constantly fighting for advantage over one another.

The asphalt companies are responsible for the ten-year maintenance guarantee; they have argued that so long as they were to keep the pavement in repair for ten years the quality of the materials to be used should be left to them. Where intelligent supervision and care were exercised by the contractor, the early asphalt pavements, as a rule, were satisfactory, for they were all built on the results of experience with one kind of asphalt. When it became necessary or desirable to use other kinds of asphalt, it was found the former criteria did not always hold.

Kansas City Experience

Kansas City, Mo., has maintained open specifications on asphaltic cement for the past ten years. The original specifications as written by Dr. Walter M. Cross, city chemist, are quoted in full in the appendix of the 1908 edition of Richardson's "The Modern Asphalt Pavement." It will be noted that no requirements are imposed on the contractor as to the kind of "raw" asphalt or flux used, but that certain tests are prescribed for the asphaltic cement used in the paving mixture, and that any asphalt passing these tests may be used, provided it shall have been successfully used in the paving industry under similar conditions for four years prior to the letting of the contract.

This idea of dealing only with the finished product and fixing requirements for the asphaltic cement as it enters the wearing surface mixture has since been successfully maintained in the Kansas City specifications. With the addition of the ductility and viscosity tests, about 8 and 6 yr. ago respectively, the requirement as to prior use of the material was dropped and asphaltic cement is now accepted for paving purposes on the basis of a series of laboratory tests only.

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Kansas City Specifications

The present specifications read as follows:

Asphaltic Cement—The asphaltic cement used in the wearing surface, when considered apart from the mineral matter which it may contain, shall have the following characteristics:

It shall be free from water or decomposition products.

The various hydrocarbons composing it shall be present in homogeneous solution, none of oily or granular character being present.

It must be of such consistency that at a temperature of 25 deg. C. a No. 2 needle, weighted with 100 grams, will not in 5 sec. penetrate more than 9 nor less than 4½ mm. The exact penetration shall not vary more than 0.4 mm. from that fixed by the city engineer within the limits specified. The No. 2 needle referred to is a common sewing needle about 1 mm. in diameter and tapering uniformly to a sharp point for 1 cm. of its length.

Twenty grams of it shall not lose more than 3 per cent. in weight upon being maintained at a uniform temperature of 165 deg. C. for 5 hr. in a cylindrical vessel 3 in. in diameter and 1 in. high.

Twenty grams of it shall not lose more than 6 per cent. in weight upon being maintained at a uniform temperature of 205 deg. C. for 5 hr. in a cylindrical vessel 3 in. in diameter and 1 in. high.

It shall be soluble in chemically pure carbon bisulphide (CS_2) at air temperature to the extent of at least 95 per cent.

It shall not contain more than 4½ per cent. of carbonaceous matter insoluble in chemically pure carbon bisulphide, at air temperature.

It shall be soluble in 85 deg. Bé. petroleum naphtha, air temperature, to the extent of not less than 65 per cent. and not more than 72½ per cent.

Its solubility in carbon tetrachloride shall not be more than 1½ per cent. less than its solubility in carbon bisulphide—both tests being made at air temperature.

It shall show of fixed carbon not more than 15 per cent.

It shall show a flashing point (New York State closed oil tester) of more than 175 deg. C.

Its viscosity at a temperature of 0 deg. C. shall not be less than 0.15 grams. Viscosity of asphaltic cement by the terms of this contract shall mean the number of grams of asphaltic cement that will, in 4 hr., be forced through a circular orifice 1.0 cm. in diameter by a pressure equal to that exerted by a column of mercury 150 cm. high. The asphaltic cement during this test shall be contained in an iron cylinder 42 mm. in diameter and 100 mm. high, and the thickness of the plate through which the orifice is made shall not be more than 2.0 mm.

Its ductility at a temperature of 25 deg. C. shall be not less than 15 cm. [The minimum until recently was 10 cm.] Ductility, by the terms of this contract, shall be understood to mean the distance in centimeters that a cylinder of the asphaltic cement, 1 cm. in diameter, can be drawn out at the rate of 1 cm. per min. The drawing out shall be accomplished by means of two similar cups cylindrical in form, of inside diameter of about 3 cm., open at one end and having a concentric orifice 1 cm. in diameter through a circular plate not more than 0.5 mm. thick, which covers the other end. To make a determination, one of the cups is placed on a smooth surface with the open end down. The other cup is then placed on top of the first, with the open end up, so that the 1-cm. orifices coincide. The hot asphaltic cement is poured into the top cup slowly, so as to fill both cups completely. The temperature of the asphaltic cement is then cooled to the temperature of 25 deg. C., and the cups are pulled apart at the rate of 1 c.m. per min.

The asphaltic cement used under this contract must not be changed as to the brand, kinds, proportions and qualities of the ingredients during the progress of the work.

All of the tests except the ductility and viscosity tests are familiar to paving engineers and chemists, are performed in accordance with the best practice of standard laboratories and require no further explanation.

Methods and Apparatus Described

The apparatus for making the ductility test is of an inexpensive design developed by Dr. Cross and has some rather striking features. Two brass cylindrical cups about 3 cm. in diameter and 6 cm. deep have a hole 1 cm. in diameter bored through the center of the bottom of each and reamed out at a wide angle from the inside so that the thickness of the plate bottom at the edge of the hole is ½ mm.

In making the test the open end of one cup is fitted over a short rubber cylinder which is embedded in a lead weight, the other cup is placed on top of the first so that the orifices exactly coincide and the two cups are filled by pouring the melted asphalt into the upper cup. After the asphalt has cooled, the cups are placed in water kept at a temperature of 25 deg. C. until the asphalt has adjusted itself to this temperature. The cups are then placed in the bottom of a glass jar filled with water at a temperature of 25 deg. C., the lead weight being used as a base.

Above the jar, on a rack, is set a metronome, such as musicians use, but from which the bottom has been removed, and which has been so adjusted that it will wind a wire on the wheel next to the spring drum at the rate of 1 cm. a min. A fine, flexible wire is attached to the upper cup, and the metronome is placed over the glass cylinder so that the pull will be vertical as tested by a plumb-bob. The metronome is started and the cups are pulled apart at the rate of 1 cm. per min. As soon as the fine thread of asphalt is seen to break and wave in the water, the metronome is stopped and the distance between faces of clips is measured.

A metronome with a strong spring should be selected, and even then it is sometimes necessary to help it along at first to get the cups started apart. The cups are carefully machined and polished so as to set tight against each other. The jar used is a heavy glass cylinder about 3 in. (4½ in. would be better) in diameter and 36 in. long placed in a round can. The bottom is sealed by pouring asphalt in the space between the can and the glass.

Advantages of the Ductility Test

The commendable thing about this test is the uniformity of results. It measures the elongation of a cylinder of asphalt 1 cm. in diameter and 1 mm. long and eliminates, as far as possible, all variable factors which might affect the results. Duplicate tests made on the same asphalt or by different observers check very closely. Although pulled at a slower rate, the elongation obtained by the Cross method is only about one-half to one-third of that obtained by the briquette method, but there is no fixed ratio between the two. The minimum limit set by the specifications is therefore more severe than that usually required. The ductility test is of course the determination of the adhesiveness of the asphaltic cement, and this is now recognized as important.

The viscosity test as first used was performed at a temperature of 25 deg. C., but on account of the difficulty in maintaining this temperature for a long period, and because it did not give all the information desired, the

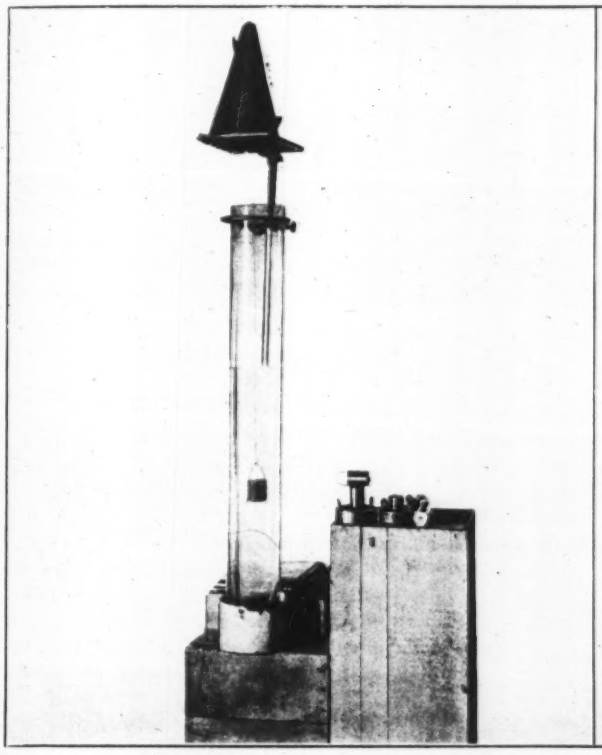


FIG. 1. APPARATUS FOR ASPHALT-DUCTILITY TEST

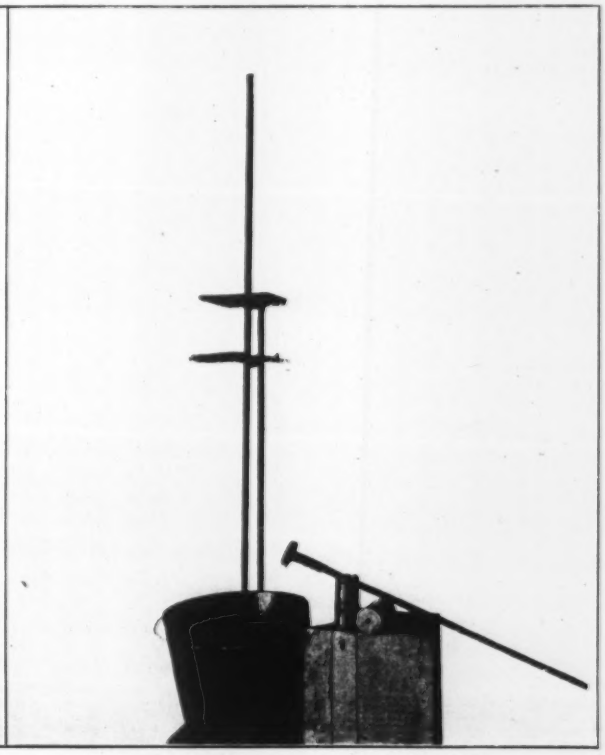


FIG. 2. APPARATUS FOR VISCOSITY TEST

0 deg. C. test was substituted. Zero temperature is easily maintained in the laboratory with melting ice.

Apparatus for the Viscosity Tests

The apparatus for this test is very simple and inexpensive. An iron cylinder of the size specified, threaded at both ends, has two threaded caps, one of which is 2 mm. in thickness with a 1 cm. hole drilled in the center; the other has a welded shank threaded for a ⅜-in. gas pipe about 145 cm. long. A glass tube is cemented into the top of the gas pipe and marked at a point 150 cm. above the bottom of the cap. In making the test the lower cap is screwed on, placed on a smooth surface and the cylinder filled full with asphalt; after this has cooled the upper cap is screwed on, the pipe is attached, and the whole is suspended in a pail of crushed ice by clamps on the iron pipe. The pipe and glass tube are then filled with mercury to the 150-cm. mark, and after about one-half hour such asphaltic cement as has been forced through the orifice is shaved off and the beginning time noted. At the end of four hours the cylinder is removed and the asphalt again shaved off, and the shavings weighed.

This viscosity test is a unique requirement for asphaltic cement and was invented by Dr. Cross to prevent cracked pavements. It has been found that asphaltic cement should have some flow even at low temperatures, so that it would adjust itself to contraction in order to avoid cracking of the asphaltic surface in winter. Since the adoption of the test no cracking has occurred where the asphaltic cement of the specified mixture showed the required zero viscosity. Most of the payments laid before the viscosity test was required did not crack, but many of them did without apparent cause.

The viscosity test makes possible the selection of an asphaltic cement which will not be in any way responsible for cracked asphaltic surfaces. It is in effect the means of testing the ductility or flow of asphaltic cement at low temperatures. A pavement built with an asphaltic cement which has some ductility at low temperatures will take up contraction by a stretching of the asphaltic film around each sand grain and will not become a brittle mass. The method of determining the viscosity, being a simple orifice test, is a true measure of the flow.

Efficiency of Ductility and Viscosity Tests

Most of the standard brands of asphaltic cement can be made to pass all requirements, except those for ductility and viscosity, with proper care in their preparation and with the use of a proper flux, although for protection against inferior grades the solubility and volatility requirements are more complete than customary. The majority of failures of asphalt submitted have been on the ductility test. The ductility test is usually made first on account of the shorter time consumed.

Of the asphalts submitted which pass all other requirements, including ductility, a number fail in the viscosity test. Some of the manufactured asphalts have been brought up to the requirements of both tests by the addition of varying percentages of natural bitumens having the properties they lack to a high degree. The fact of the matter is that no properly prepared high-grade asphaltic cement, whether natural or manufactured, which has proved itself suitable by long time usage in pavements has failed to pass the requirements. In other words, the specifications have admitted all cements which experience and good judgment show make good pavements.

The specifications have, however, passed some asphaltic cements which have been viewed with suspicion on account of their newness or origin; and while these are probably not so good as the best, they have been very satisfactory, and no failures because of the asphaltic cement have occurred in pavements laid. The specifications as outlined are made to fit the requirements of the Kansas City climate and are used for sheet asphalt and fine-graded asphaltic concrete. Where asphalt is desired for bituminous macadam, surface dressing or filler for blocks, these requirements are varied to suit conditions.

Kansas City has more than 4,000,000 sq.yd. of asphalt pavement in use on streets, exclusive of car tracks, some of which is 26 yr. old. This pavement is in all conditions, from good to bad, and has been laid under all sorts of traffic, in all sorts of manners and with a great variety of materials. Experience with these pavements forms a fair basis for present and future guidance. It has been the constant endeavor to improve the finished pavement to meet the increased severity of use, and the asphaltic cement requirements, together with mixtures and method of laying, have been modified from time to time with the idea of getting the best material and workmanship.

The testing methods outlined in the foregoing notes have proved very satisfactory over a long period of time and will undoubtedly be retained. They are presented for the consideration and discussion of those who are interested in obtaining some uniformity and certainty in testing asphaltic cement.

Municipal Research Work*

The question of research work in connection with the activities of a city is one which must be considered very carefully. Taking the country as a whole, the cities have undertaken, relatively speaking, no research work up to date. In view of the tremendous opportunity for such work and in face of the fact that at our universities and research institutions great fortunes are being spent, the isolated pieces of work carried on in our municipalities are almost negligible. My own feeling is that a part of the work now done by our cities could more properly be done elsewhere. At the present time our colleges and research institutions are the places for so-called "pure science." The net result of work of this kind carried on under existing municipal conditions is apt to be too small to warrant its being undertaken. The atmosphere in which the work of the average municipal laboratory is carried on is not especially encouraging to those types of work where results may be delayed or very definite results perhaps not even assured. On the other hand, there are varieties of work which can best be done by the cities in connection with construction.

Some day there will perhaps be instituted a generously endowed foundation for municipal research through which it may be possible to coördinate efforts of this kind in a number of different places. When this step is taken a new day will have dawned for American municipalities. Graft, inefficiency and political interference will disappear in proportion as we are able to establish definite scientific and engineering standards covering different municipal activities.

*From 1914 report of M. L. Cooke, Director of Public Works, Philadelphia.

Placing Masonry for the Elephant Butte Dam, New Mexico*

By E. H. Baldwin†

SYNOPSIS—Details of masonry work on a very large concrete dam. Masonry is rubble concrete, with smooth concrete face. Quarrying methods and grouting of cutoff wall described. (Mixing and placing of concrete and records of placing masonry will be described in a subsequent article.)

The Elephant Butte Dam is being constructed by the United States Reclamation Service across the Rio Grande at a point about 12 mi. west of Engle, N. M. It is of cyclopean concrete, will be 1200 ft. long, over 300 ft. high, and will contain in excess of 600,000 cu.yd. of masonry. It will impound 2,626,700 acre-feet of water and form a lake 40 mi. long with surface area of 40,080 acres.

The excavation for the dam was sufficiently advanced on June 3, 1913, to permit of commencing masonry work on that date, but as there was still a large amount of excavation to be done, only one cable was used on the masonry for some time.

The character of the foundation was such that it was deemed advisable to cover it with masonry as soon after exposure as possible; this was due to the stratification of the bedrock, which presented a sound and otherwise excellent appearance when first uncovered, but the great extremes of temperature in this climate would gradually open up seams that were at first imperceptible. For this reason it was considered expedient to carry on masonry operations coincident with the excavation. Whenever an area was prepared sufficiently large to make such work economical it was quickly covered with masonry. Other reasons for carrying on masonry work before the entire bottom was prepared were as follows:

A large amount of the material being excavated was sand and gravel taken from outside the neat lines of the dam. This was drawn to the outer cables by drag scrapers, picked up by grab buckets on these cables, transported to the upper railroad and carried to a storage pile for future use as concrete aggregate. This method of work rendered the middle cable useless for excavation purposes, but it was used to advantage in transporting concrete and plums to the dam and enabled a large amount of sand and gravel to be used direct from the excavation.

Using Construction Cableways for Masonry

After July 1 two shifts worked continuously on masonry, but with only one cable, until December, when one shift was transferred to excavation. In February, 1914, two shifts, but with only one cable, were used on this work, and on Mar. 1 masonry work became the main issue, with two shifts using two, and sometimes three, cables.

As will be seen in Fig. 2, a cutoff trench is excavated at the heel of the dam. This varies somewhat in section, according to the material encountered, but averages about 10 ft. wide in the bottom and 15 ft. deep below the remainder of the foundation. The bottom of this trench is in excellent sandstone, but to make sure of its solidity a number of test-holes were put down with churn drills to a depth of 25 ft. below the bottom of the trench.

*Previous articles on the Elephant Butte Dam in "Engineering News" are as follows: "Excavation for Foundation," Jan. 14, 1915; "Concrete-Mixing Plant," Aug. 6, 1914; "Construction Camp," Dec. 31, 1914.

†Assistant Chief of Construction, United States Reclamation Service, Denver, Colo.

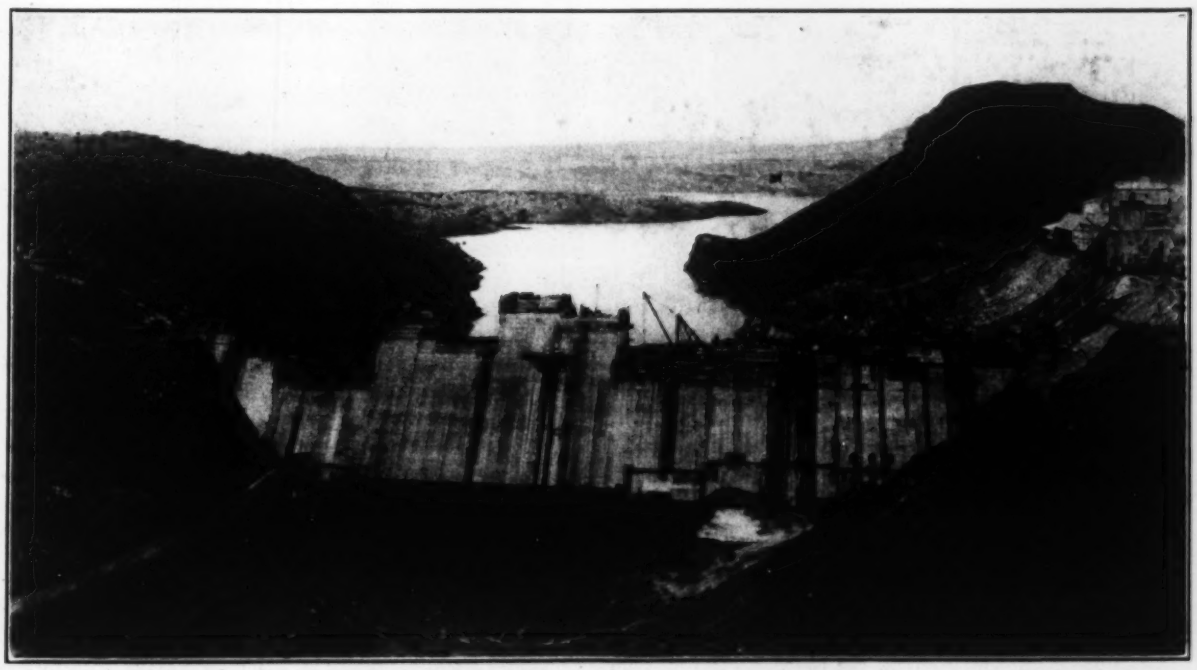
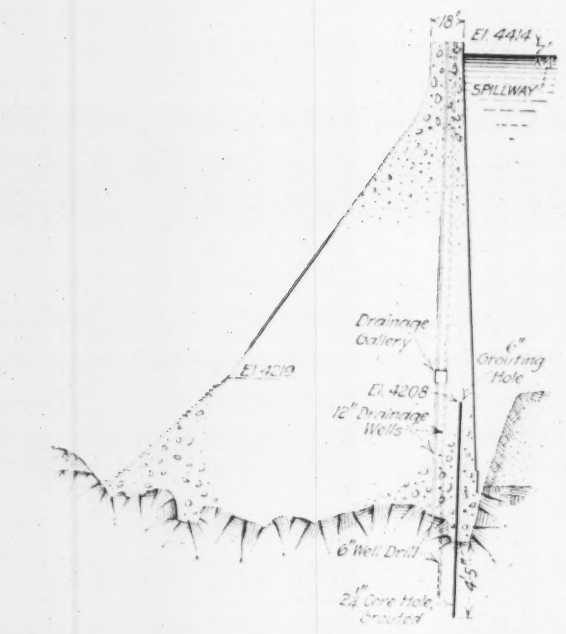


FIG. 1. ELEPHANT BUTTE DAM UNDER CONSTRUCTION

Every precaution possible was taken to prevent leakage beneath the dam or percolation through it; but in case such leakage or percolation did take place, means have been provided to lead the resulting water harmlessly away. The specifications called for a row of holes in the center of cutoff trench 10 ft. apart, parallel with the axis of the dam, to be drilled to a depth of 50 ft. below the bottom of the trench, and grouted under high pressure, to seal all accessible seams and prevent percolation under the dam. About 10 ft. downstream from the line of grouting holes a row of drainage wells, 12 in. in diameter and 8 ft. apart throughout the entire length of the axis of the dam, was provided for in the masonry to extend upward to the inspection tunnel located slightly above river bed, to discharge any water which rises to that elevation into a drainage conduit leading to the downstream face of the dam. The wells were to be drilled to a diameter of 6 in. and a depth of 45 ft. below the base of the dam. A distance of 5 ft. downstream from this line of drainage wells a similar row was provided, not extending into bedrock, but extending from the base of the dam to the inspection tunnel. These wells were staggered with reference to the wells in the upper row.



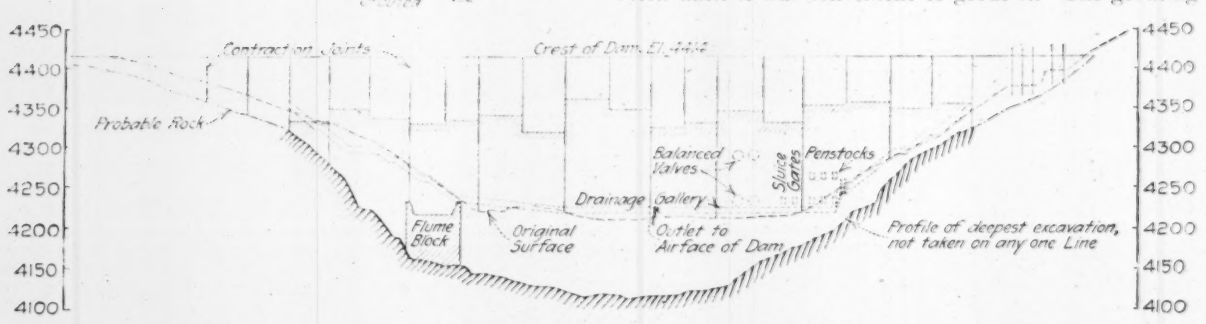


FIG. 2. ELEVATION AND SECTION OF ELEPHANT BUTTE DAM, UNITED STATES RECLAMATION SERVICE

The cutoff trench was filled with 1:6 concrete, but before filling, seats were cut in the bedrock for 6-in. iron pipes, which were set up and concreted in on the location for the grouting holes. The drainage wells were carried up in similar manner, but were cast with collapsible iron forms 12 in. in diameter. When the concrete around them had set sufficiently to allow of their removal, the forms were collapsed, removed, cleaned, oiled and put back into place for further work.

Drilling the Grouting Holes

When the masonry covering was considered sufficient, or at a convenient time, the grouting holes were drilled with a Davis Calyx drill, the shot bit being used. The operation of the machine has been uniformly successful. Cores were retained from every fourth hole and stored for future reference. This machine has drilled 59 holes to a total depth of 3125 lin.ft. As the concrete was placed rapidly it frequently happened that the drill would start from 75 to 100 ft. above the hole; but this did not make any great difference, except that it caused more tubing to be handled than would otherwise have been the case. In January, 1915, a well-drill was rigged with a 3-in. string of tools and used in place of the shot drill. While this did not furnish a core, it gave just as good results and at from one-third to one-half the cost. With this drill 34 grouting holes were put down to a total depth of 1845 lin.ft. All drilling was carried on in three shifts.

The drilling of these holes was closely followed by the grouting machine. This was a No. 2 Canniff, and was operated from one to three shifts, depending on the condition of the hole or the urgency of the case. In addition to the regular grouting holes called for in the specifications, considerable other grouting was done. Wherever cracks were found in the foundation, 2-in. iron pipe was inserted and carried up until the rock was sufficiently covered with masonry to withstand the pressure, or more often until it was convenient to grout it. The grouting consisted of 83 regular holes along cutoff trench and 93 additional holes (see Fig. 3).

Neat portland cement was generally used; but whenever a water test indicated that the hole was very loose and would consequently take considerable grout, sand-cement was utilized. The 176 holes so far grouted have taken 341 bbl. of portland and 1250 bbl. of sand-cement. The largest quantity of cement forced into one hole was 85 bbl. of sand-cement.

Holes were cleaned before grouting by forcing a stream of water through them. Seepage tests under gravity and pressure heads were made before and after grouting. Seepage before grouting varied from 0.1 to 150 gal. per hr. under gravity and from 3 to 192 gal. per hr. under pressure of 100 lb. per sq.in. After grouting, an average of 0.015 gal. per hr. under gravity and 1.5 gal. per hr.

To increase the imperviousness of the upstream face special precautions are being taken. The portion of dam upstream from the upper row of drainage wells is made of a richer mix than the remainder of the dam. This is a 1:6 mix, while a 1:9 mix is generally used. There is no sharply defined line between the two grades of concrete; forms are not used to separate them, but they are blended together in a distance of from 1 to 3 ft.

Waterproofing the Upstream Face

To discourage further the entrance of water into the dam the upstream face is being coated with portland-cement mortar applied with a cement-gun. The mortar is mixed in the proportion of 1 part cement to 2 parts sand and applied in a layer about 1 in. thick. Advantage is taken of rising water in the reservoir to work from rafts specially constructed for the purpose. There are two of these, each 9x13 ft., made of planking on a framework laid on and attached to 16 oil barrels. One raft contains the machine, operator and helpers, small mixing box and a few sacks of cement and sand, while the other is loaded with cement and sand. The order of operation is to take a strip about 10 ft. high and the length of the dam at water level, and first clean it thoroughly with scrapers and wire brushes. It is then gone over with a sandblast, using coarse sand, passed through the machine to obtain the necessary pressure. This roughens the surface sufficiently to cause the mortar to adhere to it. The surface is then thoroughly moistened from a hose and immediately followed with the mortar. This is put on in four layers, each about ¼ in. in thickness. It was found that a thicker coat than this, applied on a vertical wall, without reinforcement, would, on account of its weight, slough off before setting; but by applying in thin coat this trouble was overcome. The layers follow each other before the preceding layer has attained its final set, and so far there is no indication of a parting of the layers.

Numerous samples taken from the face showed perfect adhesion to the concrete, it being impossible in every case to break mortar from the concrete at the line of contact. As indicated in the foregoing, the operation of the cement-gun is dependent on the rise of water in the reservoir; consequently its operation is somewhat intermittent. But as the small crew employed on this feature has other duties that can be worked in between, this is not objectionable, especially as it enables a great saving to be made by avoiding the necessity of scaffolding. The total area covered to date is about 96,500 sq.ft., at a cost of 8c. per sq.ft., which includes all charges.

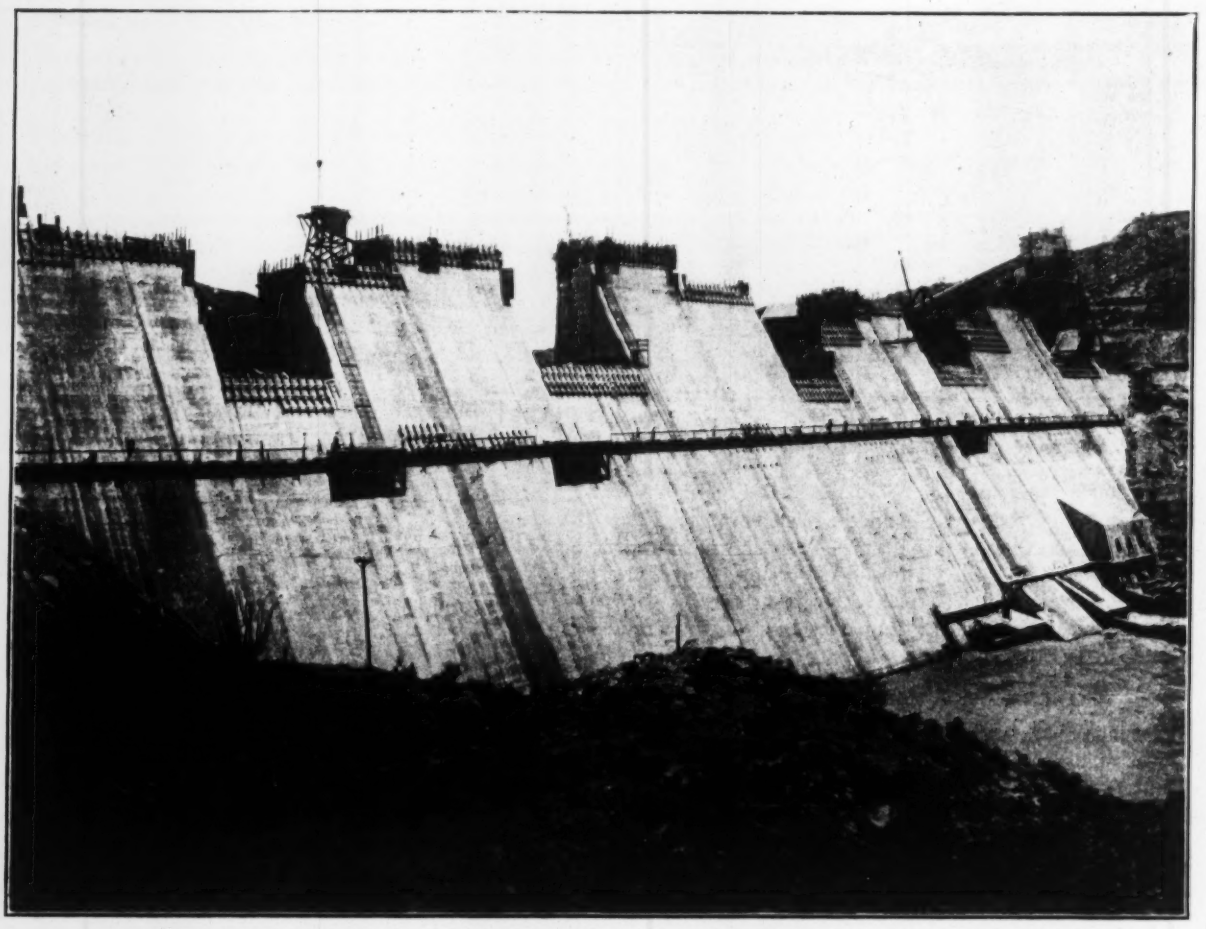


FIG. 5. DOWNSTREAM FACE OF ELEPHANT BUTTE DAM IN AUGUST, 1915
Water surface is 105 ft. above deepest part of foundation; walk is 200 ft. above foundation; completed top of dam will be 100 ft. above walk

Operation of Quarries

Three sandstone rock quarries, located from 2000 to 6000 ft. from the dam, are in use. These are known locally as No. 1, No. 2 and No. 5. First quarry 1 was

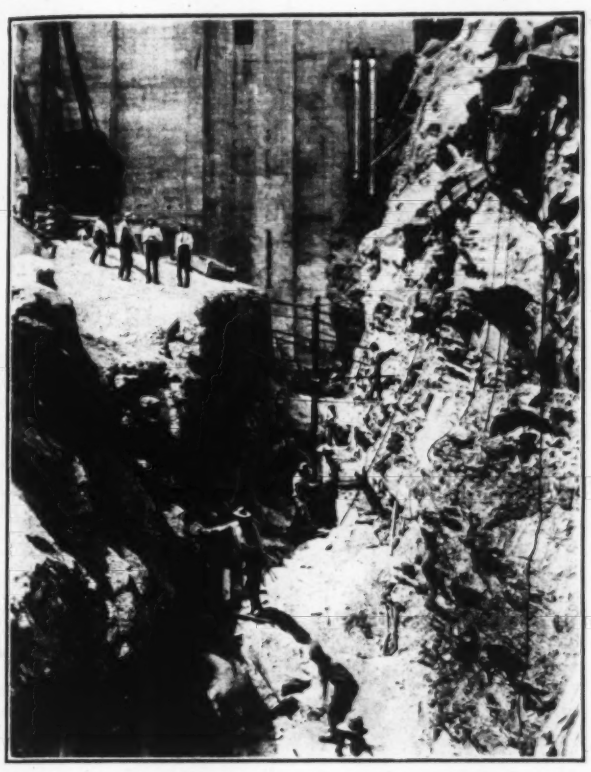


FIG. 3. PLACING GROUTING PIPES IN THE CUTOFF TRENCH AT THE HEEL OF THE DAM

under 100 lb. pressure was obtained. Three gallons per hour per 100 lb. pressure was adopted as the limit; if the seepage was in excess of this, grouting was continued until this limit was reached. Three densities of grout were used—1:7, 2:7 and 3:7 parts of cement to water, by volume. Operation was continuous with pressures from gravity to 100 lb.

Drilling Foundation-Drainage Wells

The upstream row of drainage wells was drilled with a 6-in. well-drill to a depth of about 45 ft. below the foundation. To date 165 of these holes have been drilled to a total depth of 7580 lin.ft. The purpose of this drilling was to intercept any percolation beneath the dam that might not have been cut off by the grouting, also to provide an opportunity in case percolation was considered too great, to grout this additional row of holes or as many of them as seemed necessary. As previously stated, these holes and the row 5 ft. downstream were carried up in the concrete to the floor of the inspection gallery, where any seepage water present was discharged into gutters at either side of the gallery floor and conducted to the downstream side of dam. This left a raised walk in the center of the gallery. These wells are continued from the roof of the gallery to the top of the dam, to intercept and carry off any water that enters the dam.

The effectiveness of the grouting operations has been clearly demonstrated. Careful measurements have been kept of the discharge from all drainage wells and the percolation around the abutments. On Aug. 13 this amounted to 59 gal. per min., or 0.13 cu.ft. per sec., with a head of 100 ft.

The section in Fig. 2 shows the drainage or inspection gallery and the relation of the grouting pipes and drainage wells to it. The elevation of the floor of the gallery is 4218, or about 4 ft. above the river bed, and supposed to be at all times above water level in the river below the dam. It is built the entire length of the dam, rising very slightly in grade from the low point at Station 7+30 until near the abutments, where it is carried up on a 10:8 slope.

Completed Drainage Gallery in Dam

In order to make the gallery more accessible, steps are provided on the slopes wherever steeper than 10:1. The steps are built in flights of about 25 ft. in height, with a landing; on a 10:1 slope, from 5 ft. to 10 ft. in length, according to the topography of the abutment. At one side a 1½-in. pipe handrail is provided. Conduits for electric wires were built in the concrete about 1 in. above the roof of all galleries, with openings every 20 ft. for lamps. The completed galleries and tunnels, of which there are in all about 2500 lin.ft., are well lighted and afford exceptional and convenient facilities for examining the interior of the dam and noting the percolation under and through the dam with the varying conditions of temperature and head.

It was intended to carry the drainage gallery from abutment to abutment, but near Station 9+40 the abutment was so precipitous that a vertical ladder or tunneling would have been necessary; so it was decided to end it at this point and start another about 22 ft. higher to be entered by one of the galleries provided in connection with the sluice-gate operating chambers. The drainage galleries are connected for drainage purposes by a 12-in. opening built in the concrete.

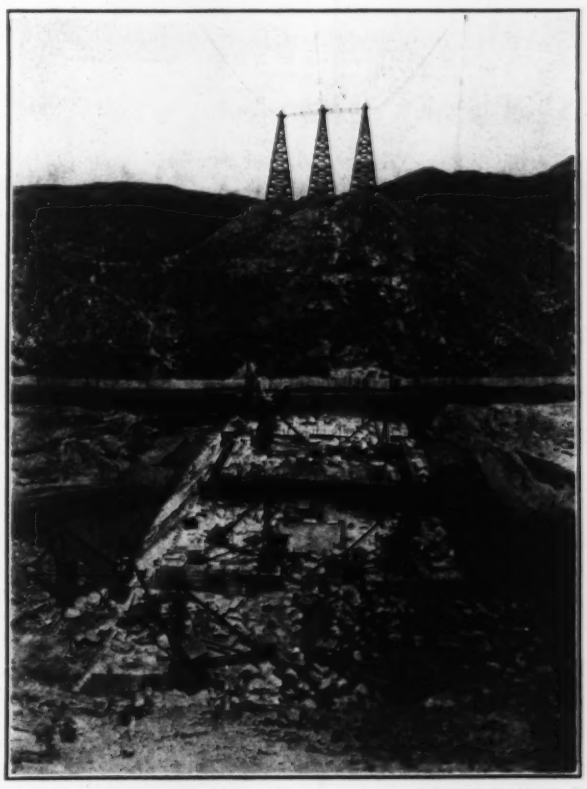


FIG. 4. FIRST STAGES OF ELEPHANT BUTTE MASONRY
Smooth surface in middle section left unroughened so that derrick pier blocks can be cast thereon

developed, but was so disappointing that No. 2 was opened up, and gave much better results. Later, in order to get more working face, No. 5 was developed, after unsatisfactory results from Nos. 3 and 4. Quarry 2 has furnished by far the greater amount of material. It contains streaks of shale, which, with the overburden of unsuitable material, gives from 15 to 20% of waste. The face as now developed is about 600 ft. long and 150 ft. high. The bulk of the rock taken from this quarry was loosened by shooting holes from 125 to 150 ft. deep, put down with a 6-in. well-drill, three or four being shot at a time. The largest single blast was in October, 1914, when four holes, loaded with 39,515 lb. of powder, were shot at once, loosening some 70,000 cu.yd. of rock.

This quarry is served by six guy derricks and a double-track standard-gage railroad. On account of the unsuitable material mixed in with the good rock, it has not been feasible to use steam shovels or other mechanical means for loading crusher rock. Rock for the crushers is broken by hand, the larger stones unsuitable for plums are plug-holed and shot and loaded into skips, which are emptied by derricks into waiting 6-cu.yd. dump cars. These are then drawn in trains of 10 or 12 cars by 16-ton locomotives to the crushers, dumped and returned for another load. Plum rock is loaded on flat cars, either in skips or chain slings, for transportation to the dam after cleaning and washing. The cleaning and washing is done on a special side track, alongside of which is a platform, built to the height of the cars, and equipped with water and air hose, pneumatic chipping tools, hammers, and numerous other tools necessary for this work. Quarries 1 and 5 are served by two derricks and one derrick respectively, and by convenient side tracks.

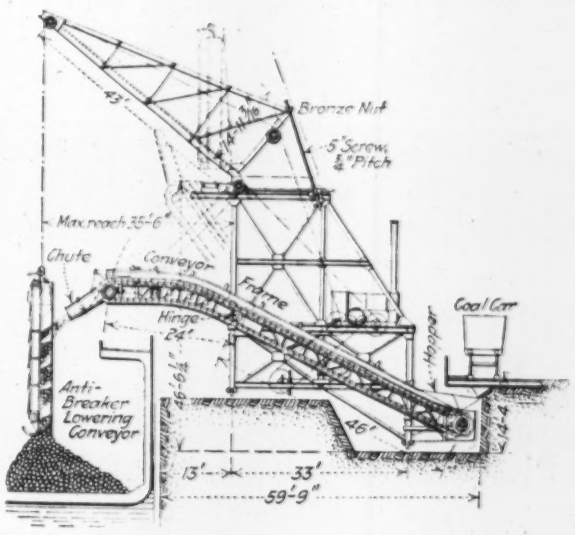
Blended-Cement Plant

With the exception of some thin reinforced work and around water outlets that will discharge under high velocity, all concrete is made with sand-cement. This is made on the work by blending the sandstone from the regular quarries with portland cement. The plant is modern and well suited to the work. It consists of rock crusher, drier, ball mill and four tube mills, with necessary conveyors, elevators and storage bins. The blend used is about 50%, but varies slightly from day to day. The product has a fineness of 90 to 93% passing the No. 200 sieve. Samples from the concrete used were at first taken daily, but are now taken semiweekly. A sufficient number are taken to provide for the following tests: 28 days, 3 months, 6 months, 1 yr. and 2 yr. A complete laboratory on the work enables these tests to be consistently carried out, and the results so far obtained from samples taken on the work bear out the previous laboratory tests that for massive work sand-cement is as satisfactory from the standpoint of strength and permanency as portland cement, and in many cases a great saving can be effected by its use. The plant has a continuous capacity of 1600 bbl. of sand-cement in a three-shift day of 24 hr.; but on account of repairs, changes, etc., from time to time it has never been run steadily on a three-shift basis. The maximum output for one month was in February, 1915, when 39,500 bbl. were produced. The operating force consists of a chemical expert, who has charge of the entire force in mill and laboratory. In the laboratory he is assisted by a chemist and a cement tester; in the mill he is represented by a general foreman, who has charge of the foremen, millers, weighers and general labor. Including the general foreman, from 7 to 10 men are required each shift.

English Ship-Coaling Machine

A coal-shipping plant installed at Workington, England, is designed specially to handle the coal with a minimum of breakage. The machine is carried by a tower traveling on a track 120 ft. long near the edge of the dock, the rails having a gage of 33 ft. In the rear of this track, and above it, is a track for the drop-bottom coal cars, the coal being discharged between the rails and delivered to a hopper on the end of a conveyor frame, which extends through the tower.

The conveyor consists of a traveling belt of steel plates 4 ft. wide, running at about 120 ft. per min. The



MACHINE FOR COALING SHIPS, WORKINGTON HARBOR

outer end of the conveyor frame is adjustable, having trunnion bearings in the front of the tower, so that it can be raised or lowered to clear deck fixtures and to give the coal as little drop as possible. The conveyor and the propelling machinery are driven from a 40-hp. engine.

A chute on the end of the conveyor frame delivers the coal to a Handcock antibreaker. This is a vertical tube suspended from a boom on the tower, and containing a series of trays attached to endless chains. The weight of the coal as it flows into the tube operates this vertical lowering conveyor. The loaded trays descend, free the coal at the bottom, and then ascend empty. An automatic brake controls the speed.

In coaling a ship, the tube is lowered till its open end is nearly on the floor of the hull, and as the coal is delivered the tube is gradually raised, keeping its end level with the top of the coal pile, so that the coal flows out without a direct drop. This machine (described in *The Engineer*, of London, July 2) is designed to deliver 400 tons of coal per hour, but can work at the rate of 600 tons per hour. It was built by F. Turnbull & Co., of Newcastle-on-Tyne, to the designs of Cecil Walton, Engineer for the Workington Harbor Board, and under the direction of Bowen Cooke, Chief Engineer of the London & Northwestern Ry.

Field and Office

Culverts Damaged by Extreme Freshet in Small Creek

By A. E. Steere*

Heavy rainfall in the Mohawk Valley and western New York State on Aug. 22, 1915, caused considerable damage to small culverts and highway bridges over small streams. One of the storm centers developed at Hoffmans; while lasting less than one hour, it caused the local streams to discharge unusual volumes of water for small watersheds. There was opportunity to get a fairly close estimate of the maximum discharge of a small stream entering the Mohawk from the north. This shows a phenomenal rate of flow per acre.

FIG. 1. CONCRETE CULVERT DAMAGED BY SETTLING OF WALLS

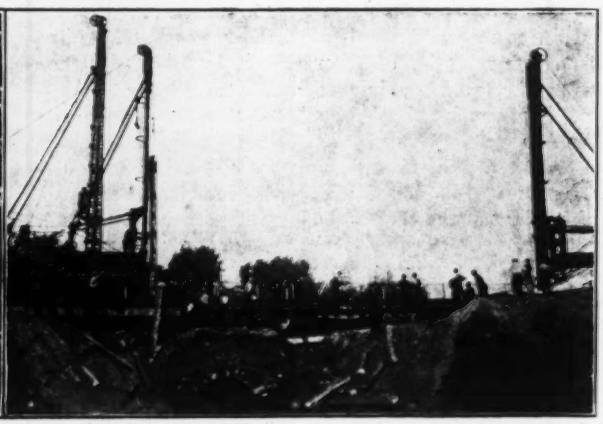


FIG. 2. OLD CULVERT PARTLY WASHED OUT WHEN FLOWING UNDER LARGE HEAD

The stream has a drainage area of about 1¼ sq.mi. The area is rectangular in plan and has steep slopes. On that account the run-off from the full area was delivered to the creek along its course at about the same time.

The creek is crossed by a double-track electric railway line, a state road, and the New York Central Railroad embankment carrying eight tracks. The electric crossing was a concrete culvert 10 ft. in span, the embankment being about 20 ft. high above the culvert. The New York Central crossing was a culvert of even smaller sectional area. At both culverts the water was dammed back so that they ran full under a head of 12 ft. in the case of the electric crossing and more in the case of the railway crossing.

The experience at the electric culvert was the more interesting. The foundation for the side walls of the structure was on heavy gravel, the bottom being the natural stream bed. The rush of water through this opening with the head of water caused scour to such an extent that the walls were undermined and sank two feet at a point about 30 ft. from the point of entrance. The spandrel walls at either end were broken at the center of the arch and separated from the barrel of the culvert along a transverse construction joint. The arch of the culvert for a distance of about 45 ft., where the greatest settlement occurred, is cracked laterally and transversely in many directions, while the edges of these lines of fracture have spalled considerably, indicating that the arch is under serious strain. A section of the side wall approximately 15 ft. long separated about 4 in. along a horizontal joint from the arch ring.

As this arch settled during the process of undermining, the water followed more readily through the soft material along the barrel of the culvert, causing the earth fill on the lower end of the culvert to flow through the large opening in the arch near the spandrel wall. The electric-railroad tracks showed a distinct sag, but were subsequently brought to grade by additional material, so that traffic could be resumed.

The cause of the failure was the undermining of the arch walls, caused by the absence of a concrete or masonry invert between the side walls. As an additional precaution where culverts may be subject to water pressure, an inexpensive cut-off wall should be placed around the arch ring within the limits of the embankment.

The culvert at the New York Central crossing was an old one which had been extended at different times, the last extension being of concrete, while the former construction was of the stone-arch type. The greater portion of this structure was washed out.

The embankment under the four main tracks and the crossover for traffic going to the West Shore tracks was washed away, leaving the rails and ties suspended across the gap. Track watchmen were on hand, which prevented accident. The railroad forces were on the site promptly with piledrivers, wrecking cranes and many cars of piles and heavy timbers making repairs (see Fig. 2).

An estimate of the maximum discharge of this creek, from observations taken after the storm subsided, would indicate an approximate flow of 1,500 cu.ft. per sec. As

*Resident Engineer, Mohawk River District, New York Barge Canal; Mark Building, Amsterdam, N. Y.

...ated, the watershed covers about 800 acres. One of ...e old formulas used in designing small culverts is

Area of opening = $c \times$ *drainage area in acres*

...here c is assumed to vary from 1 to 4, according to ...e slope conditions of the drainage area. By this formula the culvert was much too small.

Soil-Bearing Test with Confined Plunger

The Detroit-Superior viaduct, Cleveland, has most of its piers founded on piles driven in hard clay. Driving these piles was very difficult, and in redesigning the east abutment and one pier the engineers believed that the foundation piles should be eliminated. To verify this opinion a bearing pressure test of the soil was made, as shown by the view in Fig. 1.

FIG. 1. SOIL-BEARING TEST AT LOAD OF 8 TONS PER SQ.FT.

The test was carried up to a loading of 13½ tons per sq.ft., at which the settlement was about two inches. The settlement readings were very slight up to a load of 8 tons per sq.ft., which may be considered the equivalent of a yield point, and was so interpreted. The relation between settlement and load is shown by curve in Fig. 3. Each load was left on for a certain length of time before more load was added, and at most of the loads settlement occurred in this waiting period. Separate settlement-time curves for these intervals are shown in Fig. 4. The curves were plotted by A. W. Zesiger, bridge engineer, Cuyahoga County, who is in charge of the viaduct work. The testing arrangement, shown by the sketch Fig. 2, is interesting in the use of a confined plunger. A base-block 2 ft. square, set on the bottom of a square sheeted pit about 4 ft. on a side, is surrounded by a 6x12 curb fastened to the sheeting by a nailing strip. Clay packing is put between the sheeting and the back of the curb to prevent the rising up of the bottom soil in this space. The clearance between curb and plunger is ¼ in., the inside size of the opening of the curb being ½ in. larger than the plunger. The effect of this arrangement seems to have been complete prevention of any rising-up of the soil, so that the full bearing power of a buried foundation was presumably realized. The clay subsoil found at the site is particularly liable to lateral flow and heaving up at un-

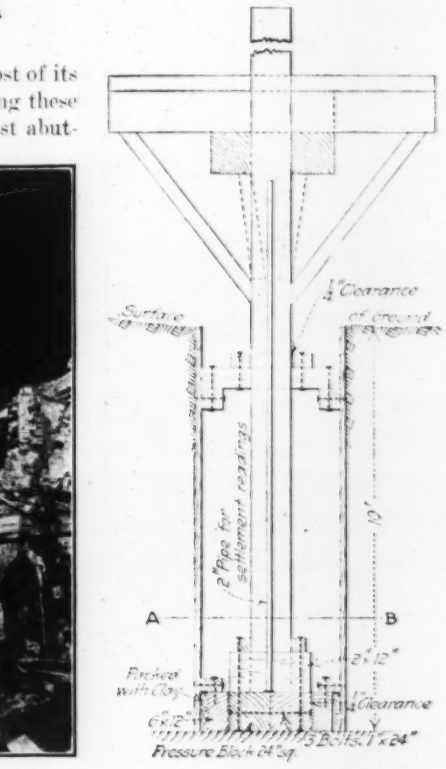


FIG. 2. SKETCH OF RIG FOR SOIL-BEARING TEST

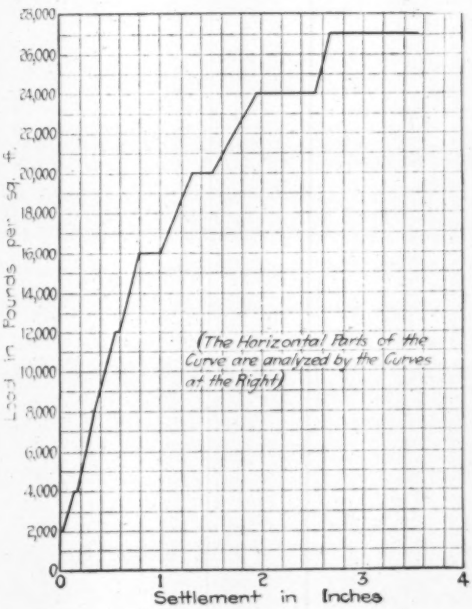


Fig. 3. Increase of Settlement with Load

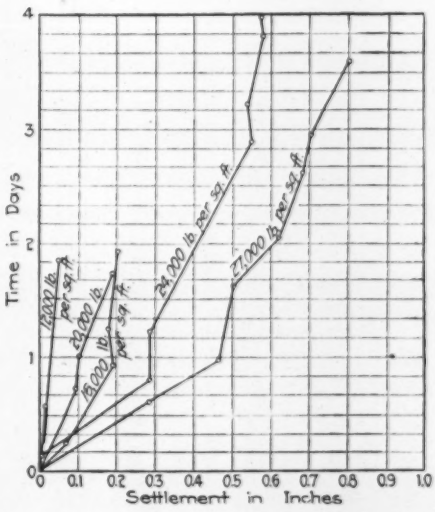


Fig. 4. Settlements at Constant Load

FIGS. 3 AND 4. ANALYSIS OF SOIL-BEARING TEST AT DETROIT-SUPERIOR VIADUCT

loaded points under the influence of a concentrated load, so that the precaution was particularly necessary in this case.

Load Test Under River Piers

The river piers of the same viaduct were founded by concreting under water direct on the clay bottom of an excavation inside a coffer-dam without piles. To verify their bearing capacity a load test of the bottom soil was made after a 16-ft. depth of the pier substructure concrete had been placed. A well 36 in. in diameter was cored in the concrete, and a 34-in. diameter plunger was set on the bottom soil in this hole. A load of 10 tons per sq.ft. on this plunger produced a settlement of 0.21 ft. The foundation was approved on the strength of this test.

New Sewer Inlets at St. Louis

By S. Chivvis*

The Division of Sewer Design of the Engineering Department of St. Louis has recently made some important changes in its standard types of street inlets and in its policy of trapping them.

Heretofore all inlets connected directly to the sewers have been built with catchbasins and have been trapped

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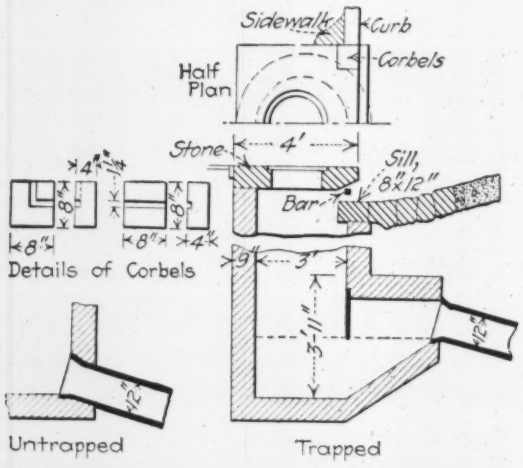


FIG. 1. OLD SEWER INLETS

FIG. 2. EXTERIOR VIEW OF OLD SEWER INLET

as shown in Fig. 1. This type (see also the view, Fig. 2) has been rather expensive on account of the massive brick neck and heavy stone. The corbels at either side of the opening, which were primarily intended to support the two front corners of the stone, are complicated by the necessity of molding into their upper surface inserts to admit the bar. The sill, which should be shaped to allow the water to drop suddenly and surely from the gutter into the inlet, has not accomplished this end, having a broad flat upper surface laid horizontally.

The result of the last-mentioned defects has been that a large amount of the water for which the sidehill or lateral sewers have been computed has rushed past the inlets it should have entered, and gorged those at the foot of the grade.

The difficulty has been met partly by a redesign of the inlet itself with a slightly greater length of steeply inclined spillway and partly by closer coördination be-

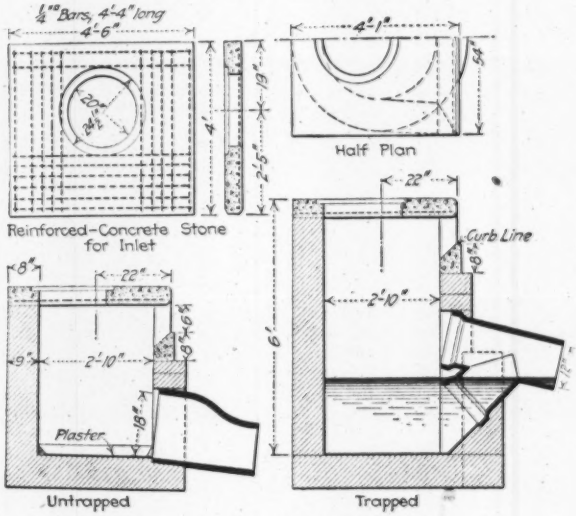


FIG. 3. NEW SEWER INLET

tween the sewer and street paving divisions in the matter of gutter depressions at the inlet face. In addition, the more sparing use of traps and catchbasins makes possible the placing of a greater number of inlets at a lower cost per unit.

Fig. 3 shows the details for both the trapped and untrapped types of the new design. The use of the trapped type with catchbasin is contemplated on inlets connected to sewers of flat grade where, on account of the sluggish flow, septic action will have a chance to begin, and on inlets draining telford streets on grades steep enough to allow the gravel to wash into the gutters. This latter case could of course be met by the use of the catchbasin alone, but the standard trapped inlet is used to avoid a multiplicity of types. All inlets not falling into the two categories mentioned will be untrapped.

With regard to the stone or cap, the old St. Louis practice called for hewn limestone of a thickness of 8 in. With the advent of concrete this thickness was retained, no reinforcing being used; but the natural eagerness of contractors to push their work led to a great number of breakages caused by loading and unloading these stones when comparatively green.

The new cap design saves 45% in weight (967 lb. complete, compared with 1,740 lb.) while adding materially to the strength under live-loading. This strength

makes unnecessary the use of corbels to support the overhanging corners, and the absence of corbels allows a greater length of spillway with a smaller stone, the new dimensions being 4x4½ ft., while the old were 4x5 ft.

Cost of Motor-Truck Hauling Depends on Conditions

Engineering News of Sept. 16, 1915, published an article by D. P. N. Little in which he described how a motor truck and trailer hauled two 11-ton girders 61 ft. 10 in. long a distance of 24 mi. from the Los Angeles shops of the Union Iron Works. He compared the cost of transportation of these two girders with the costs submitted in my article on "Motor Trucks for Heavy Structural Steel" for the Jerome Ave. elevated railway structure in New York City, *Engineering News*, July 22, p. 174. Mr. Little succeeded in cutting his costs of hauling these girders to approximately one-half the cost of those hauled on Jerome Ave. I think it is only just to explain the differences in the costs of the two pieces of work.

The average length of haul on the Jerome Ave. section is two miles, a greater part through unpaved streets with barely room for a truck to pass between the storage piles of girders, which compelled slow and careful operation. In a 10-hr. day these trucks are in actual operation only half of the time; the other 5 hr. is consumed in loading and unloading, the unloading being done by hand. It is obvious that the trucks are making only half the ton-mileage in a 10-hr. day that they would make if they were in continuous operation, as in Mr. Little's case, where the distance between the shops and the girders' destination was 24 mi. "over thoroughly improved oil-macadam roads."

Again, the assumption of $20 per day per truck is liberal, but by no means in excess of the actual cost of maintenance, which runs high on account of the wear and tear on motor cars that have hauled as high as 25 tons on a load. The costs submitted by me have run over a period of nine months, during the most inclement months of the year, as compared to Mr. Little's assumptions for depreciation of motor cars and trailers, derived from a service period of two or three days.—William Collins, Jr., Inspector for Public Service Commission, New York City.

An Underrated Contributor to Steel Construction

By R. Fleming*

The history of bridge and building failures is mostly a story of faulty details. Seldom has a structure given way for lack of strength in the main members. But eccentric rivet connections bringing about large bending moments, connections that induce secondary stresses, insufficient lacing of compression members, have all invited disaster. In the final analysis the cause of failure has been that the importance of the detailer's work was underrated. The recent failure of the Panama crane "Ajax" might have been averted if there had been more knowledge shown in the detailing of a large compression member.

*American Bridge Co., 30 Church St., New York City.

The draftsman often does not realize that his opportunities are of enough importance to call forth his best energies and the use of all the knowledge he may possess. The graduate from a technical school is apt to regard the time spent in the drafting room merely as a stepping stone to something else. He does not think it worth while to make the occupation permanent. The highly standardized systems in use in the drafting rooms of the large structural-engineering offices prescribe so much that he thinks there is no call for initiative on his part. The practice of some firms of drawing their supply of draftsmen from evening and trade schools or from an apprentice system tends to lessen the value of a knowledge of mechanics and the laws of stresses.

Money Can Be Saved by a Detailer

Aside from averting failure, the draftsman can do much in lessening the cost of shopwork. Countersunk rivets are expensive, yet how often the base of a column is filled with them when half the number would answer. The writer once made designs and estimates for a series of roof trusses to be used as standards. About the time they were finished it was found that a truss detailed in the drafting room weighed less than the standard truss of the same span, loading and main members. The draftsman, by an ingenious arrangement of field splices and a careful study of details, had effected a saving of at least $200 on the estimated cost of the roof. A careful scrutiny of his work showed no lack of strength or nonconformity to rules or instructions. Of course he could have made no such saving on every roof. It would not have been made on the roof in question if the span had been 2 ft. more or 3 ft. less.

Structures are sometimes detailed with but little regard to transportation, making freight rates excessively high because of space occupied. This is particularly true of export work. The cost of field riveting and the rates for transportation should be carefully compared and studied.

A Thousand Dollars Lost in Erection

Another opportunity of the detailer is to bring about ease of erection, thus saving field costs. One large structural firm makes a specialty of a final examination of all working drawings in order to eliminate every possible field rivet. The erector of an office building in Philadelphia was put to an expense of $1,200 for cutting out and replacing rivets in columns. The columns were made of 8- and 10-in. web plates, four angles and two cover plates. Without giving the subject much thought or making inquiries, the detailer assumed that the erector could spread the columns and drop the connecting girders between them. At the site this proved so difficult that it was found cheaper to cut out rivets, swing in the girders, and then drive new rivets. If the connections had been properly detailed, $900 of the $1,200 could have been saved. Insufficient clearances are also fruitful causes of trouble and expense. These can usually be avoided by previous study in the drafting room.

The remedy for poor and expensive detailing lies partly with the draftsman and partly with the firm that employs him. Greater inducements should be held out by firms than are offered at present. The ideal draftsman is a designer—a designer of details.[1] Estimating his value

[1] "The Designing of Details," "Engineering and Contracting," Feb. 10, 1915.

from the cost per sheet of his drawings or the cost per ton of material detailed may be misleading. A few years ago the contract for a complicated steel structure in the Pennsylvania coal regions was awarded to a firm of limited experience that had considerably underbid all competitors. One cause for the low bid was that the assumed cost of drawings was about half that of other bidders. However, by hiring students at nominal wages from a near-by technical institution, the firm succeeded in having the drawings made within the estimated cost. But the cost of erection! Every dollar saved in the drafting room cost two in the field.

What is usually considered the designing of a structure may be comparatively easy, but the detailing may be difficult. The rewards for good detailing should be commensurate with the service rendered. This does not mean that the designer should receive less salary, but that the detailer should receive more. And as previously mentioned, he should be a designer of details and recognized as such.

Testing Large Water Meters

A new equipment for testing water meters of 3-, 4- and 5-in. sizes was installed at the testing laboratory of the St. Louis, Mo., water-works in 1914. The special features of this equipment are an air cushion for water hammer, a quick-opening valve, a sliding joint to accommodate meters of various lengths, clamps instead of bolts for holding the meters between the flanges of the machine, pressure gages at inlet and outlet ends of the meter, various sizes of orifices, and an overhead trolley.

All fittings, except where otherwise specified, are wrought iron; the air cushion is a section of 12-in. cast-iron pipe about 4 ft. long; the 50-cu.ft. measuring tank is a 12-ft. section of 30-in. cast-iron pipe set on a concrete base. There is a drain from the dished concrete foundation under the meter connection to the sewer.

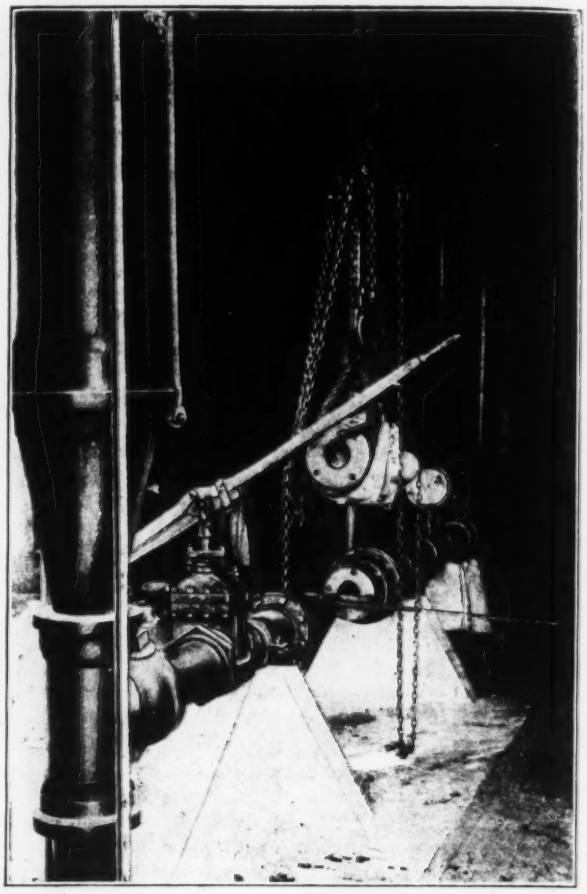


FIG. 2. VIEW OF ST. LOUIS TESTING PLANT FOR LARGE WATER METERS

The ends of the 6-in. wrought-iron pipe to which the flanges of the meter connection are attached are held on their concrete piers by wrought-iron bands riveted to ½x2½-in. iron straps bent to conform to the outline of the pier and bedded in the concrete. The concrete foundation under the testing pit is reinforced with four ½-in. round bars, as shown in Fig. 1.

The illustration, Fig. 2, shows the lever for moving the sliding connection in or out and also two of the clamps for fastening on the meters.

The Water Commissioner of St. Louis, Mo., is Edward E. Wall, to whom credit is due for the drawings and information given.

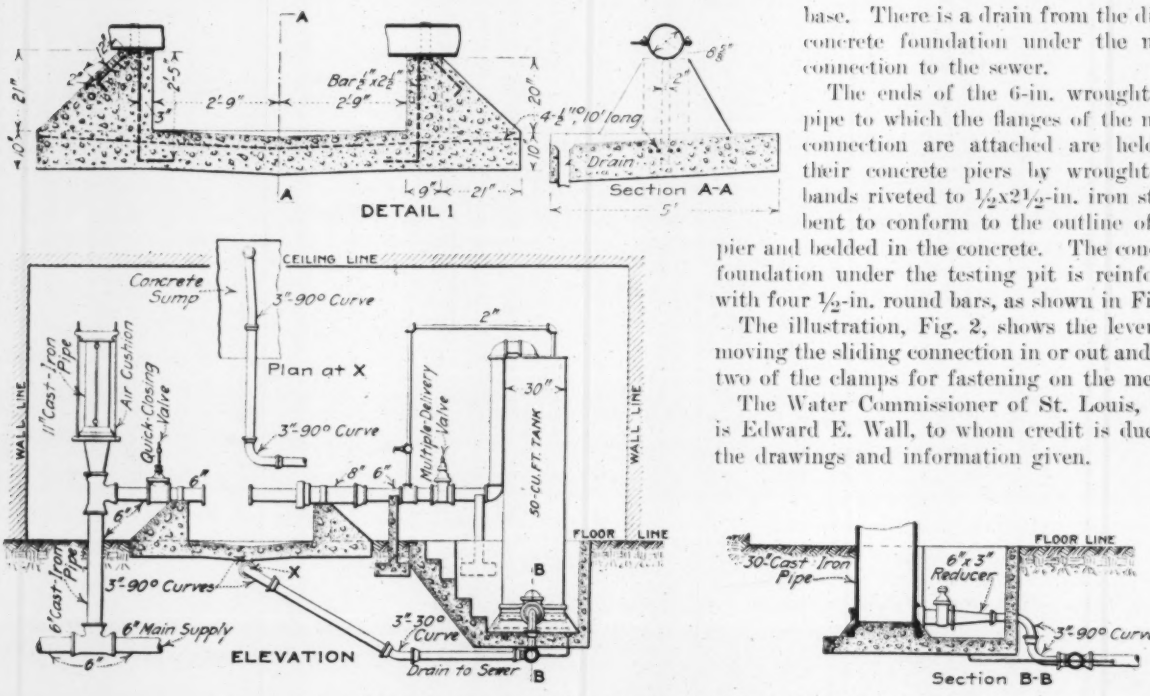


FIG. 1. EQUIPMENT FOR TESTING LARGE WATER METERS, ST. LOUIS, MO.

Large Steel Grandstand for Automobile Racetrack

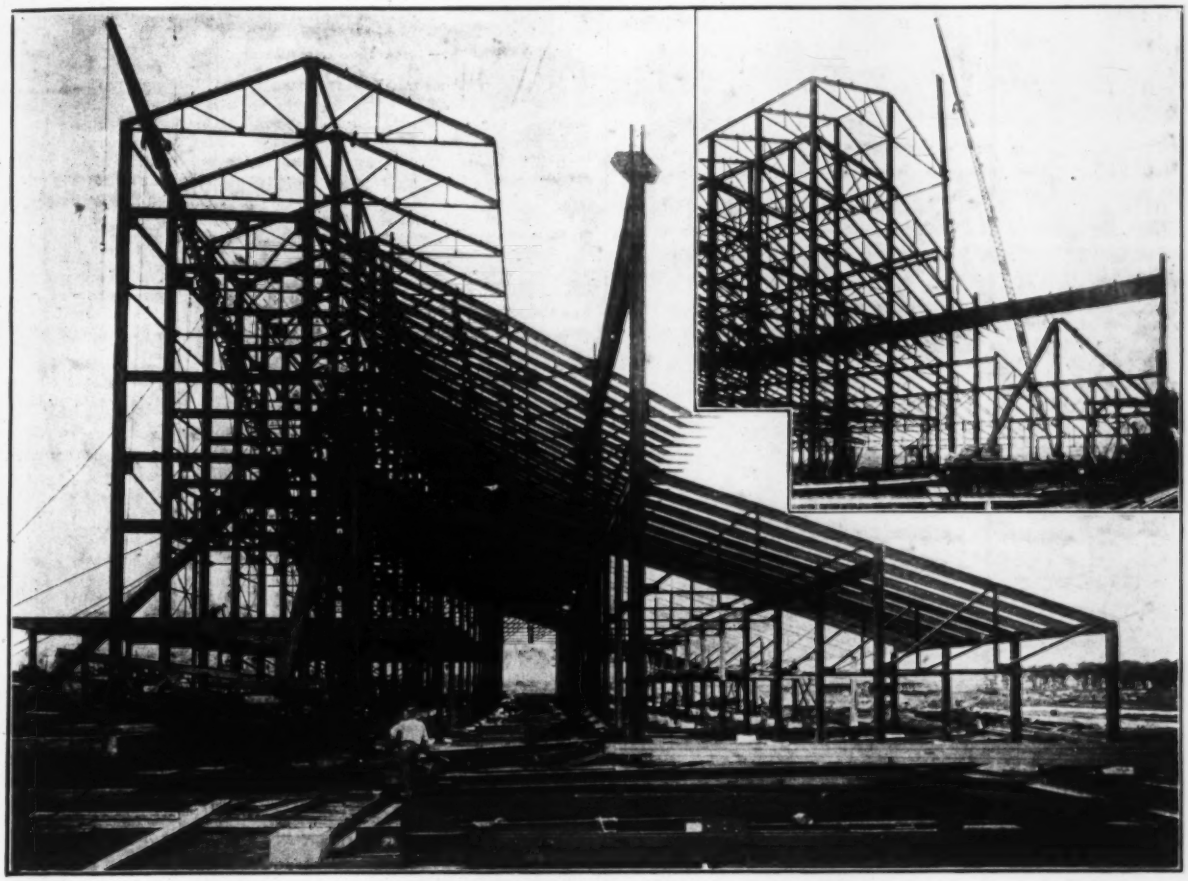
The costly two-mile racetrack for automobiles at Sheepshead Bay, N. Y., nearly completed, has a grandstand ranking among the grandest in the world. It is 1,200 ft. long by 110 ft. deep in plan, has two seat-banks and in front of the lower one a four-tier line of boxes, and contains some 2,700 tons of steel. The boxes are framed in wood. The two views herewith, showing the framework during erection, exhibit the arrangement clearly.

Fore-and-aft bents of six columns carry the trusses of the seat-banks and roof. The bents are spaced 16 ft. 4 in. apart, but the front line of columns under the balcony is spaced 49 ft. (that is, there is a column at every third bent only) to reduce the obstruction of view from the upper half of the main seat-bank. Longitudinal bracing between bents occurs in alternate bays of the three main column lines, and in every fourth bay of the other three lines. The fore-and-aft bracing consists of portal trusses under the seat-banks. Field-connections are riveted.

The five bays of the bent are 17 ft. 5 in. to 21 ft. 6 in. long, giving a depth of 93 ft. for the main part of the stand. Back of this is a three-story extension one bay in depth, containing longitudinal corridors and toilet-rooms.

The steelwork is of normal design and detailing throughout. The seat-bank stepping is carried by fore-and-aft I-beam joists, which divide the bays of the frame into three spaces. The stepping is built up of 2x6 studs supporting risers and treads (or seats), all built up on spiking strips bolted on top of the I-beam joists. The seat proportions are 10½-in. rise to 32-in. tread in the main bank, and 16½-in. rise to 32-in. tread in the balcony, or slope-ratios of about 1:3 and 1:2 respectively. The roof consists of asbestos shingles on sheathing on wooden purlins, with wooden outlookers to carry the eaves.

The height from ground to top of main seat-bank is 35 ft., to top of balcony 65 ft., and to peak of roof 84 ft. This required using a boom spliced out to 90 ft. long, on the derrick traveler (see views) which erected the main members of the framing. This traveler was carried by four two-wheel trucks running on a two-rail track laid longitudinal to the grandstand near the middle of the depth. It could reach all parts of the bent.



GRANDSTAND STEEL PARTLY ERECTED; DERRICK IN FOREGROUND

Blaine H. Miller, Chief Engineer of the Sheepshead Bay Speedway Corporation, was in charge of design and construction. The Lackawanna Steel Co. furnished the steel, and the Lackawanna Bridge Co. erected it. Erection began June 5, and by Sept. 17 the steelwork had received its final coat of paint.

Although in an outlying district, the racetrack is within the city limits, and the New York Building Code governed. Plans were approved by the Bureau of Buildings of the Borough of Brooklyn, which required the seating banks to be designed for 75 lb. per sq.ft.

NOTES

Batch Mixers To Be Rated By Mixed Batch—Some mixer manufacturers rate their machines by their capacity in mixed concrete, while others rate them by their capacity in loose unmixed material, although it is a well-known fact that a mixer having a batch capacity of 8 to 9 cu.ft. of unmixed sand, stone and cement will hold only about 6 cu.ft. of mixed concrete per batch. The National Association of Mixer Manufacturers at its August meeting took steps toward remedying this difficulty by adopting a resolution providing for the uniform rating of batch mixers. This resolution provides that the members of the association in future catalogs and circulars shall specify the capacity of their mixers as "size of wet mixed batch," and not otherwise. The dry unmixed capacity of a mixer, says the association, may be approximated at 1½ times the wet mixed batch, assuming the use of cement, sand and 1½-in. crushed stone, with 1¾ gal. of water per cubic foot of mixed concrete. The members of the association further agreed not to use the dry-batch rating in their correspondence, advertising, etc., unless the standard wet-batch rating was used also and with equal prominence.—From H. E. Smith, Secretary, National Association of Mixer Manufacturers, 1125 32nd St., Milwaukee, Wis.

Highway Signs Made of Old Saws—A unique sign for marking the various highways has been devised by Arthur P. Denton, of Seattle, Engineer of King County, Wash. Discarded shingle saws have been purchased, the rust removed and the steel disk painted as shown in accompanying sketch. The saws can be purchased in bales for practically the price of crating and taking them away from the mills, and as this is particularly a lumber country, the signs are peculiarly

HIGHWAY SIGN MADE OF OLD SHINGLE SAW

appropriate. To protect the signs from mutilation at the hands of hunters, and as targets for the rocks of small boys, the Board of King County Commissioners has had posted warning notice that a term in jail would result from the mutilation of any county property, and teachers in the various public schools have been instructed to warn their small charges. Several hundred signs have been erected and more will be added from time to time as neded.—C. A. Osier, Seattle, Wash.

Handling Plaster by Wheelbarrows and a hoist was the method employed for the interior finish of a reinforced-concrete building at Stevens Point, Wis. The plaster was mixed by hand and shoveled into steel wheelbarrows. A steam hoist on the ground had its cable led through a boom on the tower of the concrete elevator, and a landing platform projected from the floor where the plastering was in progress. The end of the cable had a three-rope sling; one rope had a hook which engaged the wheel of the wheelbarrow, and the others had iron rings to be slipped over the handles of the barrow. Four men were employed: One mixed the plaster and loaded the wheelbarrows; one handled the hoist; one wheeled the barrows to and from the hoist, attached and detached the sling and held a tag line to steady the barrow and keep it clear of the building in raising and lowering; the fourth man was on the upper floor to swing in the loaded barrow on the landing platform, unhitch the sling, wheel the barrows on the floor and attach the sling to the empty barrows.

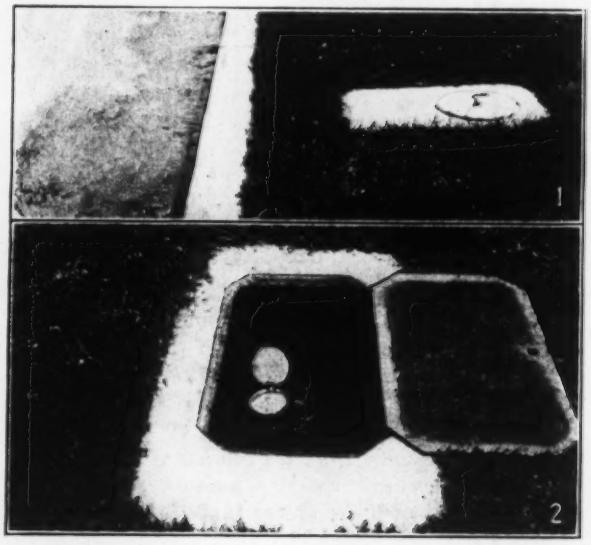
A Large Shop for plate and angle work, under construction by the Aberthaw Construction Co. for the Fore River Shipbuilding Corporation at Quincy, Mass., will be 188x769 ft. Its steel columns are composed of unusually large rolled sections, some of them 30-in. 200-lb. I-beams. The crane girders along each side of the center row of columns, as well as those along the walls of the building, are all 28-in. 150-lb. I-beams. The crane rails are about 28 ft. above the floor, while the first story reaches a total height of some 44 ft. The building is roofed with plank covered with tar and gravel. The sides are largely of glass in steel mesh, with pilasters of brick. There is one very high story for handling plates and angles for shipyard work. A partial second story above this includes the mold loft, 605x92 ft., and the sheet-metal shop, 164x92 ft.—S. G. Koon, Boston, Mass.

Using a Pneumatic-Hammer Drill Under Water is described by Charles A. Fritz, who during the summer and fall of 1914 was engineer in charge of the construction of a sewer outfall at Manchester, Mass. The outfall extended ½ mi. into tidal waters ranging in depth below mean low water from zero to 40 ft. At a depth of about 16 ft. two small ledges were encountered in the trench. The contractor (the T. A. Scott Co., New London, Conn.) had a timber crib, which was to be used to support a steam drill on a tripod. Mr. Fritz suggested the use of a "Jackhamer" pneumatic-hammer drill, which was successfully tried. The only drawback to this use of the drill was that the exhaust annoyed the divers, but this was easily remedied by bringing the exhaust to the surface by the use of a common garden hose.

Reducing Square Feet to Acres—Mr. Andrews' short cut in computing acreage ("Engineering News," Sept. 9, 1915, p. 512) involves two multiplications. Try this:

Square feet multiplied by 0.000023, minus 0.02 for each figure in the result in all ordinary cases; or, where accuracy within 0.001 is essential, subtract 0.019 instead of 0.02 for each figure or integer.—C. M. Lawrence, County Surveyor, Hughes County, Holdenville, Okla.

Cement Water-Meter Boxes of two types now being used by the City of Pasadena, Calif., are shown by the accompanying views. The smaller of the boxes shown (Fig. 1) is about 10x18 in. in plan and 14 in. deep and its walls are about 1½ in. thick. The round cement lid is lifted by a piece of heavy cord.



CEMENT WATER-METER BOXES, PASADENA, CALIF.
1—Small box with cement lid. 2—Large box with iron lid

A box for larger meters (Fig. 2) is 14x30 in. in plan, 18 in. deep, has walls 2 in. thick and is provided with an iron lid.—From Arthur Marple, Tropico, Calif.

Editorials

Safety in Subway Construction

The coincidence of two serious accidents in the subway-construction work in New York within three days has aroused uneasiness to the point of alarm. City officials share with the general public the uncomfortable suspicion that miles of timbered streets over the excavation for new subways are unsafe. The feeling is justified. Coincidences inevitably are suspicious. The first accident, Sept. 22, was alarming enough, with its mysterious spread of a local collapse to a general wrecking action that traveled along the timbering up to the point where permanent steelwork was in place. When the same contractor's work was visited with a second collapse only three days later, the municipal authorities became aroused. The coincidence struck even the slowest mind. A third collapse, however accidental, would probably make the suspicion a certainty.

To conclude anything from the fact of the coincidence is wrong in the present case, however, because the two accidents were fundamentally different in character. Any engineer, and for that matter nearly any layman, will clearly recognize this from the description printed elsewhere in this issue, drawn up on the basis of observations and sketches made on the ground. The Broadway accident was due to what the lawbooks call an act of God, in this case a catastrophal rock fall. Rock falls are not quite so unforeseeable as hurricanes and floods, but they remain the ever-continuing threat in rock excavation, whether for mine or structural use. Mining engineers, who boast of the perfection of their timbering practice, admit that the heaviest proportion of mine fatalities is due to rock falls.

The Seventh Avenue collapse is unquestionably a very serious matter. But any thoughts or sentiments based on it should not be complicated by reference to the Broadway accident.

What is more, if the relation between the two accidents is rightly interpreted the second collapse is reassuring with regard to the very danger which the first collapse seems to point out. The alarming thing about the Seventh Avenue collapse was its spreading from the point of initial failure. The man in the street concluded that the underground falsework was built more or less like a house of cards, that a loose or weak construction was being employed to support streets carrying heavy and dense traffic, and that therefore anything was liable to happen along the work, since the slightest give or fall at any one point would spread, tearing down whole block-lengths of streets. If this same man considered the circumstances of the Broadway accident, however, he could see good proof that the street supports are in fact robust and stable. The impact of hundreds of tons of rock against the timbering brought down only the little section of the street directly over the slide; immediately alongside, the posts and struts held, while the broken parts pulled clear.

Judging from the present attitude of New York City authorities and citizens, it seems to have been the popular idea that subway construction is a class of work which is 100 per cent. safe. The city officials themselves appear to have joined in this belief, forgetful of the fact that engineering construction enterprises of large magnitude cannot be wholly divested of risk. Cutting away the earth and rock under long lengths of city streets, supporting a dense and heavy traffic over the working pit, dealing with variable rock strata and uncertain building foundations, protecting suspended pipes and sewers—such operations cannot be made mechanically regular and certain, or safeguarded against all chance happenings.

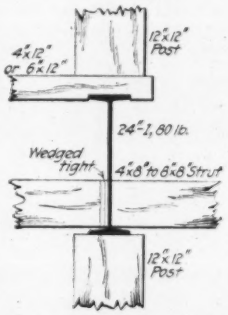
The risk remains. It cannot be eliminated, though it can be reduced, even down to a minute remnant if desired. Care and safeguard may be multiplied up to the point where added complexity and delay add danger. Increased safety-margins may be used and increased provision made against abnormal contingencies. All this, of course, is at a price. Still some risk will be left.

The present occasion is well suited, therefore, for a careful review of the subway situation to determine how much severer the requirements should be or how much more cautiously the work should be conducted than is customary in first-class engineering construction elsewhere. Some modifications, it may perhaps be found, can be made at small cost, and these will doubtless recommend themselves to all. For the rest, however, the financial question—how much can we afford to spend for it—must first be thrashed out. New York will never pay as much to safeguard Seventh Avenue against the possibility of traffic interruption as it will to safeguard Broadway. At present the Broadway and Seventh Avenue contracts are on the same footing.

But such a review must be general. To adopt only such refinements or safeguards as are directly indicated by the present accidents would be a vain measure. The same chance causes will likely not act again—others would come to light. Groups of domestic and foreign engineers have been assembled by various of the city authorities to study the timbering of the excavations. It has not been heard that investigations of blasting, dynamite handling, underpinning, water-pipes, concrete mixtures and all the other phases of the work are to be carried on. But these matters should be studied as well as the single one now in the spotlight. It is useless to shut one door to trouble if other doors are left open.

To discuss the original and most interesting element in the situation, the great collapse in Seventh Avenue, is not easy while the official inquest is yet to be held and many points of evidence must be brought to light. These will probably refer to the origin of the collapse, however, a matter which is only of minor interest to engineers. As to the timbering itself, fairly good data are given by the sketches elsewhere in this issue and a word of comment is possible and indeed inevitable.

The weak-kneed makeup of the post system is the striking feature of the timbering. Drawn in true proportion (see sketch alongside), it is an assemblage that the structural sense hesitates to accept. Instability of the post as a whole and doubtful stability of the I-beam forming its middle section are inherent in the assemblage. In the absence of longitudinal bracing in the structure, nothing to hold the posts from buckling except the spreader timbers between the I-beam webs, a moderate disturbance of the middle of the post system would be able to bring down a whole forest of these posts. As to whether this was the actual happening in the collapse of Sept. 22 can only be speculated. A blocky piece of the bench, shot out by a blast so as to hit the forward one in the tier of I-beams, could readily start the buckling of the posts.



POST SYSTEM AND MAIN BEAMS

State Control of City-Owned Utilities Much Needed

The need for as complete supervision over municipally owned utilities as over private companies has been presented in the editorial columns of *Engineering News* from time to time and from various viewpoints. Necessarily, in these discussions there has been little specific information presented on the experiences of any of the public-service commissions of the country and no data on the extent to which the municipal utility departments have been lax. Naturally, these are matters on which the commissioners and their engineers have felt hesitant to speak. Therefore it is of special interest to show specific information on the way in which utility regulation works out in its daily detail and to give definite comparisons between municipal and private utilities. Some notes of just this sort are found in a paper by C. M. Larsen, Chief Engineer of the Wisconsin Railroad Commission, printed in the September *Journal* of the American Water-Works Association.

Wisconsin is generally looked on as one of the most enlightened states in the matter of utility regulation, and it is one where equal demands are made on public and private enterprises. But evidently the responses are not uniformly satisfying. In 1914 there were 196 privately owned electricity works and 72 municipal plants. There were 26 private water companies and 163 municipal water departments. All the telephone systems and gas-works were under private control. Of the private electric plants 53% made unsatisfactory reports and so did 71% of the municipal departments. Among the private water companies 42% made unsatisfactory reports and 71% of the municipal water-works were lax. Interest in the development of the respective utility arts is reflected in the membership of utility associations. Seven of the 26 privately owned water companies had joined one or the other of the major water-works associations, which is far too few, but worse yet only 10 out of the 166 municipal water departments were represented. In the state electrical association, whose membership probably comprises practically all the local private companies, there were four departments and five individuals representing municipal works.

Continual violation of commission regulations has required repeated inspections to hold up the service standards established. The troubles were usually excess voltage or gas pressure, low heat value of gas, failure to test customers' meters, and unsatisfactory reports. (No standards were then imposed on water-works.) In all of these ways the private companies were the lesser offenders and showed a more stable management. At one municipal electric plant the engine broke down and lighting was entirely discontinued. An inspector arrived on the scene, hunted up a traction engine, connected it to the generator and restored the service. The water department of a large city was found to be pumping raw river water into its mains. The commission on investigation found vacant land near-by from which a good well supply could be developed. The city was required to develop the project, install pumping machinery and safeguard its customers.

All this evidence points to the great need for adequate means of holding the municipal utilities to the same standards of service which it is reasonable to demand of the private concerns. Could a multitude of little local regulating commissions have coped with the situation successfully? In each case of inferior service an experienced board with a staff of well-trained engineers, accountants and inspectors has been necessary to assist and supervise the weaker utilities. Few of the local municipalities could have afforded such an organization, and without it all effective control would have disappeared. Moreover, attempted regulation of one department by another branch of the same municipal government would have usually produced no benefit. "Home rule" pushed to such an extreme as advocated by the opponents of state-utility regulation means no rule at all.

The remarkable progress of violet-ray water disinfection in the United States is shown by the article published on page 634 of this issue. All of the plants thus far installed are small, and many if not most appear to have been built with little regard to cost, the process being an alluring one from various points of view. The ultra-violet ray seems to be far outdistancing ozone as a means of water disinfection. Neither method has yet made much progress as a means of disinfecting municipal water-supplies, and neither is likely to overtake chlorination in popularity and cost efficiency for years to come, if ever. The company developing ultra-violet apparatus, however, is quietly working upon the problems of large-scale disinfection though it is not actively seeking municipal business at the present time.

The blowing up of the sewage-pumping station at Batavia, N. Y., on Sept. 17 adds another to the growing list of explosions which seem to be due to either gasoline or illuminating gas that has accumulated in sewers and wrecked either these or structures connected with them. The cause of these explosions should be given more study than it has yet received, and far more attention should be given to the detection and prevention of such dangers. One of the simplest of precautionary measures is never to carry an unprotected light or strike

a match in a sewer, tank or pump-well where there is the least likelihood that explosive gases may have accumulated.

⁂

Now that a letter-ballot vote of 2,024 to 592 has given the Board of Direction of the American Society of Civil Engineers a free hand to favor or oppose legislative bills for the licensing of engineers, it will be interesting to see what it will do when the next opportunity arises.

⁂

"Drink at your own risk"—meaning water, of course—is the rule of law laid down by the learned judge of Pickaway County, Ohio. More specifically: A water company need exercise only "reasonable care" to see that its supply is not infected, but a water consumer must use extraordinary care to guard against danger of infection provided the danger has become the subject of "common talk." Some details of the lawsuit in which this rule was announced are given elsewhere in this issue (page 631). Perhaps the evidence in this case warranted no other conclusion in a suit for damages, but it seems to show clearly that here was another typhoid outbreak due to a defective check valve between a polluted mill supply and the water-supply of a city.

⁂

All "topsy-turvy" would describe most city plans in America. This is no wonder, since with very few exceptions they "just growed." How difficult it is to make good this lack of planning, even in areas still largely undeveloped, and how much may be accomplished when a determined attempt is made, are shown by the first of two articles on city planning in Queens Borough, on pages 638-41 of this issue. One of the lessons of the article now printed is the need and value of a good topographical survey for any thoroughgoing city-planning task.

Letters to the Editor

Why Railway Engineers Often Fail in Highway Work

Sir—In the article headed "Give the Experienced Engineer a Chance in Highway Work" in *Engineering News* of Aug. 19, Mr. Mielly falls into the common error of assuming that highway and railroad engineering are the same thing. It is true that there is much similarity, but it is more a similarity of form than of substance. Take the question of grades. For a reasonable distance a horse is capable of exerting a pull twice or three times as great as his normal tractive power, and for this reason, within reasonable limits, one maximum grade on a highway does not of necessity limit the loads that may be drawn over it. For illustration, a series of long 3% grades may have more influence on traffic than one 5% grade. In other words, highway grades and railroad grades are two entirely different propositions. In the latter case, one maximum grade will limit the length of trains on an entire division; in the former case, a corresponding statement would in all probability not be the truth.

There is no question but that an engineer who has had several years of experience on railroad construction would be a valuable man on highway construction if he would adapt himself to the change in conditions and requirements. But that is just the rub. As a general rule he cannot or will not do so. I served my time on a railroad-engineering corps, and am quite free to admit that I received as much benefit from the experience as the railroads I worked for did from my services; but I could not help noticing that the rank and file of the men in the corps, who had been in railroad work for from ten to twenty years, were in a hopeless rut. They were excellent cogs in a powerful and efficient machine, but apart from that or a similar machine their value was certainly open to question.

This may explain why recent graduates, willing and able to learn, may be preferred to old hands who have forgotten how to adapt themselves to changed conditions. Again, a young man, fresh from school, is much more apt to exert himself in a position that pays $75 a month than an older man, who is likely to resent instructions and to think himself above the job. Blunders due to pigheadedness are usually much more expensive than those due to inexperience, and whereas the latter fault can be corrected, the former rarely yields to treatment.

B. K. Coghlan,
Associate Professor of Highway Engineering.
College Station, Tex., Aug. 27, 1915.

NOTES AND QUERIES

Concrete Ties—A correspondent inquires as to the reasons why concrete ties have not been a practical success. One of the main troubles is the disintegration of the concrete caused by vibration and pounding under traffic. Some of them have cracked and fractured. The weight, the cost, and the necessity (in most cases) of special fastenings are other unfavorable factors. Some ties have given good service, however. Concrete ties of various designs have been proposed, and several of these have been tried in the track, but only in small numbers, so that the aggregate number of such ties is very limited.

Relative Size of Engineering Societies—Referring to the footnote on p. 569 of "Engineering News" of Sept. 16, 1915, Edw. C. Sherman, of Boston, remarks that the Boston Society of Civil Engineers, which had a membership of 962 in June and has since admitted some new members, should have been given as ranking next in size to the Western Society of Engineers. Mr. Sherman also states further that it seems probable that by "Associated Engineering Society" was meant the Association of Engineering Societies, and calls attention to the fact that this association is really composed of various local engineering societies banded together for the sole purpose of publishing their proceedings jointly, so that it ought not to be compared with any single engineering society of equal size.